Estimating Market Equilibrium Values of Fruit Attributes for Apple and Strawberry Using Choice Experiments with Consumers and Producers

A DISSERTATION

SUBMITTED TO THE FACULTY OF UNIVERSITY OF MINNESOTA

BY

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IN PARTIAL FUFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

Dr. Chengyan Yue, Advisor

January 2015

Jong Woo Choi, 2015

ACKNOWLEGEMENT

This piece of work could not be done without my advisor's help. Prof. Chengyan Yue has directed me to participate in RosBreed project and taught me lots of skills on behavioral economics. Also, I am very thankful to my advisor's encouragement and guidance for completion of my dissertation. She has guided me during entire my graduate study and inspired me to study behavioral economics. She taught behavioral economics at my third year, and this inspired my interest in this field. Also, it was a great honor to work with her during my graduate school at the University of Minnesota – Twin Cities. Thanks to her help with graduate assistantship, I could continue my graduate school and complete my degree.

I, also, like to thank my other committee members, Prof. Robert King, Prof. Terry Hurley, and Prof. James Luby. I have known Prof. King for about 3 years from the beginning of my graduate school. He has encouraged me to conduct research in agricultural economics and gave me lots of suggestions for my school work. His sincere and genuine advice is influential and helped me continue my graduate program. Prof. Hurley taught two of my classes and always helped me without any hesitation. He was my interim advisor and provided critical guidance during my first year at the University of Minnesota. Without his help, I could not even stay in the Minnesota. Prof. Luby helped me gain a deeper understanding of the horticultural market and the breeding process, which makes my dissertation more transdisciplinary. He always would like to give me valuable advice on apples and strawberries.

This research is supported by the Specialty Crop Research Initiative of USDA's National Institute of Food and Agriculture. Prof. McCracken, Prof. Gallardo, and Prof. McFerson, also, reviewed my dissertation and provided valuable comments. Thanks to RosBreed project, I gained invaluable experience on working in transdisciplinary teams and

leaned how to apply the theories of experimental economics to solve real world problems and finish my graduate program. From this project, I have learned how to design and conduct choice experiment, construct survey questions and analyze large datasets.

Furthermore, Prof. Jong-ho Jeong at Seoul National University encouraged me to study and complete my graduate program. He always taught me how to survive in a graduate school when I dropped by his office at my hard times. I thank Prof. Kwon at Seoul National University whose lectures on Environmental economics inspired me to set my foot into agricultural economics. I also thank Prof. Inhyuk Ha, Prof. Wonho Chung, and Dr. Jinyoung Moon for their encouragement and advice. Also, I thank to my team members who are advised by Prof. Chengyan Yue. Shuoli Zhao and Jingjing Wang helped and encouraged me for the completion of my degree. Also, I thank my roommate Suhyun Jung and other graduate students (Won-fy Lee, Jongwook Lee, Jaeseok Lee, and etc.) in the Department of Applied Economics at the University of Minnesota – Twin Cities for their encouragement and friendship.

Much appreciation, definitely, goes to my family who supported me from the beginning. Through my academic journey, my parents, Chang-kyu Choi & So-young Han provided unconditional support and love. Without their sincere support, I could not even start my graduate program. More importantly, I would really appreciate for their ceaseless praying. Also, I thank to my brother (Chong-won Choi), my sister-in-law (Min-kyoung Kwon), and my nephew (Min-soo Choi) for their great support, advice, and continuous encouragement.

I would like to give special thanks to my beloved pretty fiancé, Jae Eun You. Without her ceaseless and sincere support and prayer, I could not even complete my degree. During my school year, she has been supporter, encourager, prayer, and the tonic for my study. Only what

I can say to her is “I thank you and love you.” My most special thanks go to God who created me and lead me to study for his purpose.

DEDICATION

This dissertation is dedicated to my parents

for their love, patience, understanding, and endless encouragement.

ABSTRACT

Rosaceous fruits, which comprise some 90 genera with over 3000 distinct species, are one of the most important plant families and constitute the economic backbone of some U.S. rural areas. Apples and strawberries are two of the most important Rosaceous fruits. To meet the dynamic consumer demand, and to keep apple and strawberry industries sustainable, innovation through development and commercialization of new cultivars has become an increasingly important strategy. Apple and strawberry breeders have been continuously releasing new cultivars. Since 2006, 74 new strawberry plant cultivars have been released in the U.S.

Development of new cultivars requires extensive genetic knowledge, trained personnel, and significant financial resources, so it is crucial for breeders to focus on the attributes most preferred by the key supply chain stakeholders such as consumers and producers. However, producers and consumers often have different preferences and values for fruit attributes. Therefore, incorporating willingness to pay (WTP) data from both parties can be challenging.

To tackle this challenge, we used choice experiments to collect consumer and producer preference data, and then employed mixed logit models to analyze the choice experiment data and simulate each individual producer's and consumer's WTP for the fruit attributes. Based on the simulation results, we derived the supply and demand curves for each fruit attribute, synthesized consumers and producers' WTP information, and derived the equilibrium prices and quantities for each fruit attribute.

The apple attributes included in the choice experiments were appearance, crispness, firmness, flavor, shelf-life, size, and price. The strawberry attributes were external color, internal color, firmness, flavor, shelf-life, size, and price. The choice experiment data was

collected through a combination of mail-in and online surveys with growers and online surveys with consumers. In total, we got 321 completed apple grower surveys, 86 completed strawberry grower surveys, 801 completed apple consumer surveys, and 1137 completed strawberry consumer surveys.

We found producers prefer apples with longer shelf-life and intense apple flavor, and high crispness. Consumers prefer very crisp apples, and apples with intense apple flavor and good appearance. Producers prefer strawberries with intense strawberry flavor, high firmness and with ideal red external color. Consumers prefer strawberries to have ideal red internal and external color and intense strawberry flavor. After incorporating both consumer and producer preferences and WTP information, we found that for apples the highest equilibrium price and welfare are for crispness, and for strawberries the highest equilibrium price and welfare are for internal color.

By estimating the equilibrium prices and quantities, total revenue and total surplus for each fruit attribute, we successfully synthesize producers and consumers' WTP results. Our results provide important information on what attributes would generate the highest total revenue or social surplus so that breeders can allocate their resources accordingly to focus on the improvement of these attributes.

JEL Classification: C90, Q11

Key Words: apple, strawberry, fruit attributes, choice experiment, consumer, producer

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CHAPTER 1.

INTRODUCTION

The plant family Rosaceae, which is comprised of some 90 genera with over 3000 distinct species, includes fruit crops that constitute the economic backbone of some U.S. rural areas (Illa et al., 2011). This botanical family is of considerable economic importance and includes a range of crops with diverse end use: almond, apple, cane berry, cherry, pear, peach, plum, strawberry, and ornamentals such as rose. In the human diet, rosaceous fruits contribute essential vitamins, minerals, dietary fiber, and other nutrients that help reduce the risk of cancer, heart disease, and other chronic diseases (Ding and Lu, 2004). Apple and strawberry are two of the most important rosaceous fruits with consistent consumer demand. From 2000 to 2010, the mean annual per capita consumption of apples was 8 kg and the average annual production was 4.3 million tons on 152,000 ha (USDA, 2013a). Mean annual return to producers was $0.59 per kg and $1.37 per ton for the fresh and processing markets, respectively. The total annual revenue for the apple industry was $2.2 billion. From 2000 to 2010, U.S. strawberry production averaged 1.1 million metric tons on 20,904 ha and was worth $1.5 billion dollars annually (USDA, 2013b).

To meet consumer demand and to keep the apple and strawberry industries sustainable, innovation through development and commercialization of new cultivars has become an increasingly important strategy. New cultivars with superior performance and market acceptance provide advantages to the supply chain with products that are more desirable, available, affordable, healthier, and safer (Gallardo et al., 2012). The apple and strawberry industries have been continuously releasing new cultivars. Since 2006, at least 74 new strawberry plant cultivars have been released in the United States (U.S. Department of Commerce, Patent and Trademark

Office, 2013).

Development of new cultivars requires extensive genetic knowledge, trained personnel, and significant financial resources, so it is crucial for breeders to focus on the attributes most preferred by the key supply chain stakeholders (Alpuerto et al., 2009; Luby and Shaw, 2001). Identifying these attributes is challenging and very few studies of crop plants, including Rosaceae, have evaluated the value of fruit attributes to the key stakeholders along the supply chain, such as growers and consumers (Zimmermann and Van der Lans, 2009). To our knowledge, no published research has compared how consumers and producers value fruit attributes and synthesized these values at the producer and consumer levels in the market equilibrium. Our study begins to fill this gap in the literature. Specifically, we aim to find answers to the following questions: What are consumers willing to pay for their desired apples and strawberries fruit attributes? What costs are producers willing to bear to produce apples and strawberries with their desired attributes? Are there any differences between consumer willingness to pay (WTP) values and producer WTP values? What are the market equilibrium prices for these fruit attributes? What are the market equilibrium quantities for apples and strawberries with the fruit attributes? To answer these questions, we conducted choice experiments with consumers and producers using mail-in and online surveys. Mixed logit models were used to estimate consumer and producer WTP for desired apple and strawberry attributes and to derive the consumer demand curves and producer supply curves for the attributes.

This dissertation consists of five sections. Following this introduction section, the literature on consumer and producer preferences and WTP for apple and strawberry attributes are reviewed. The third section describes methodology, focusing on the survey design and data collection details as well as introducing of the mixed

logit models. The fourth section summarizes the results, containing a summary of the mixed logit models and the estimated WTP values and welfare analysis results. The last section concludes the paper and presents the marketing implications.

1.1 *Literature Review*

A number of studies have investigated consumers or producers' preferences and WTP for apple or strawberry attributes. Most have focused on consumers' preferences or WTP for apple cultivars or attributes. Yue and Tong (2011) found that cultivars SweeTango® (Minneiska cultivar), Zestar!® (Minnewashta cultivar), and "Honeycrisp" are preferred more than other cultivars such as Fuji and Gala by Minnesota consumers. These preferred apple cultivars have more desirable levels of attributes such as crispness, sweetness, and tartness than do the other cultivars. McCluskey et al. (2007) found that consumers in Portland, Oregon regard firmness and soluble solids as important attributes for Gala apples. Also, McCluskey et al. (2013) found that firmness and sweetness are the most important attributes impacting Portland consumers' purchases of apples, and that Hispanic consumers are more willing to buy more Red Delicious than Gala apples. Peneau et al. (2006) found that taste, aroma, and freshness (degree of crispness and juiciness) of apples are the three important attributes for consumers in Switzerland. Additionally, the perception of freshness was affected by consumers' age and gender. Skreli and Imami (2012) concluded that the apple origin, size, and variety are the most important attributes for consumers in Albania. Moser and Raffaelli (2012) surveyed consumers in Trentino, Italy to investigate their preferences for four apple attributes including production method (organic or sustainable), appearance (mediocre or good), origin (Italian or Trentino),

and production method with low greenhouse gas emissions (are used or not used). They concluded that organic methods are preferred more than some innovative methods such as grown with low greenhouse gas emission and apple appearance is not as important. Loureiro et al. (2002) investigated Potland, Oregon consumers' WTP for eco-labeled apples and they concluded that female consumers with children are more likely to pay a premium for eco-labeled apples. Wirth et al. (2011) used choice experiments to investigate apple consumer preferences for nutrition, quality, sustainability, and food safety in Pennsylvania. They found that consumers' WTP for locally grown and organic apples are not significantly different from each other and consumers focus more on quality of apples than other attributes. Kaye-Blake et al. (2005) investigated New Zealand consumers' WTP for genetically modified (GM) apples and found only a fraction of their participants are concerned about GM apples but they are likely to pay more for non-GM apples. Novotorova et al. (2008) employed an online survey to assess to what extent consumers prefer locally grown and non-GM apples to conventional apples. The results indicated that consumers are willing to pay about 65 % more for locally grown apples and the premiums are higher if the apples are both non-GM and locally grown.

Although many studies have investigated consumers' preferences and WTP for apple attributes, very few studies have investigated consumers' preferences and WTP for fresh strawberry attributes. Earlier studies concluded strawberry flavor, sweetness, juiciness, freshness, and firmness as the most important attributes for consumers (Ford et al., 1996; Safley et al., 1999). Recent studies have been done outside of the U.S. Germany strawberry consumers preferred strawberries with low sugar content and Uruguay consumers preferred sweeter and firmer strawberry cultivars (Keutgen and Pawelzik, 2007; Lado et al., 2010). In the U.S., Colquhoun et

al. (2012) found that consumers preferred strawberries that are sweet and with rich and complex flavors.

In contrast to the numerous studies presented above which have focused on consumer preference and WTP for fruits such as apples and strawberries, studies on producers' WTP are very limited. Some recent studies on producers' preferences for apple and strawberry attributes have been conducted by Yue et al. (2013 and 2014). They found that flavor and crispness are important for apple producers and firmness, flavor, and shelf-life are important for strawberry producers.

Most previous studies only focused on either consumers' preferences or producers' preferences for apple or strawberry attributes. Our study is poised to be the primer in analyzing both consumers' and producers' preferences for fruit attributes and synthesizing WTP information from consumers and producers to identify the quality attributes that glean the highest market values. The results will provide valuable information to assist the apple and strawberry breeders in setting attribute priorities in their breeding programs and help the industries decide what cultivars to grow to meet the market needs.

CHAPTER 2.

METHODOLOGY

2.1. *Survey Design and Data Collection*

Choice experiments were employed to elicit consumer and producer WTP values for apple and strawberry attributes. Choice experiments have been widely used by researchers to study consumer preferences and willingness to pay for goods (Darby et al., 2008; Tonsor et al., 2009; Wang et al., 2010; Rousseau and Vranken, 2013). The theoretical basis of choice experiments is random utility theory and Lancaster's consumer demand theory that assume consumers derive utility from attributes of a good rather than from the good itself (Lancaster, 1966). Choice experiments represent goods with a combination of attributes, so researchers can estimate the value for various attributes simultaneously. Additionally, choice experiments are similar to actual purchasing situations in which experimental subjects make choices from a number of goods (Lusk and Schroeder, 2004).

The attributes included in the apple choice experiments in this study are crispness, flavor, appearance (extent of defects), size, shelf-life, and price for consumers (cost for producers). Each attribute has two levels. We tailored the descriptions for the attributes and their levels to the consumer and producer groups surveyed. The levels of the attributes are summarized in Table 1 (producers) and Table 2 (consumers).

Table 1. Apple Attribute Levels in Producer Choice Scenarios

Attributes	Level 1	Level 2
Appearance	More than 3% defects per lot	Less than 3% defects per lot
Crispness	Very crisp	Not crisp
Firmness	More than 14 lbs	Less than 14 lbs
Flavor	Intense flavor	Mild flavor
Size	More than 2.9 inches	Less than 2.9 inches
Shelf-life at retail	Good (More than 1 week)	Poor (Less than 1 week)
Total cost of production/storage/handling	$24 / carton (42lbs)	$12 / carton (42lbs)

Table 2. Apple Attribute Levels in Consumer Choice Scenarios

Attributes	Level 1	Level 2
Appearance		
Crispness	Very crisp	Not crisp
Firmness	Firm	Moderately firm
Flavor	Intense flavor	Mild flavor
Size	More than 3 inches	Less than 3 inches
Shelf-life at home	Will last more than 1 week	Will last less than 1 week at

	at home in your refrigerator	home in your refrigerator
Price	$2.99/lb	$1.39/lb

Table 1 shows the levels of attributes used in the choice scenarios for apple producer choice experiments. More technical descriptions have been used for the attribute levels for producer choice experiments than consumer choice experiments. The levels were determined by consulting with apple industry experts. Percentage of defects is used to describe the good or bad levels of appearance. For crispness, the two levels are simply "very crisp" and "not crisp." For firmness, the two levels are more than 14 lbs and less than 14 lbs, respectively. For flavor the two levels are "intense flavor" and "mild flavor." The shelf-life for producer survey is described as shelf-life at retail and the two levels are "more than 1 week" and "less than 1 week." Total cost of production, storage, or handling is $24 or $12 per carton (one carton is 42 lbs). Prices were the cost of production and were consistent with prices reported by the U.S. Department of Agriculture prices paid to producers (USDA, 2013c), and consultation with the apple industry.

For consumer choice experiments, non-technical wording and visual aids were used to describe attribute levels (Table 2). The levels were pre-tested using surveys with a small number of apple consumers. Apple pictures were used to clearly describe appearance. For apple firmness, the two levels are "firm" and "moderately firm." For size, 3 inches instead of 2.9 inches is used for simplicity. Shelf-life was specified as "will last for more (or less) than 1 week at home in refrigerator." Prices used were collected from different retail stores and were consistent with U.S. Department of Agriculture apple retail price reports (USDA, 2013c).

For strawberry attributes, we included external color, internal color, firmness, flavor, size, shelf-life, and price (cost for producers). Table 3 summarizes strawberry attribute levels in producer choice scenarios. Level 1 represents the superior attribute level while level 2 represents the inferior attribute level. Bigger size was expressed as "More than 25 g/fruit". Also, superior internal and external colors were represented as "Ideal red color" and inferior color as "Too light or too dark color." Firmness has two levels "Firm" and "Soft." Flavor was defined as a combination of sweetness and sweet/tart balance, and flavor had two levels: "Full/intense flavor" and "Weak/mild flavor." Longer shelf-life was expressed as "9 days after harvest." Lastly, the two levels of total cost of production/storage/handling were $1.00 /lb and $1.15 /lb, respectively.

Table 3. Strawberry Attribute Levels in Producer Choice Scenarios

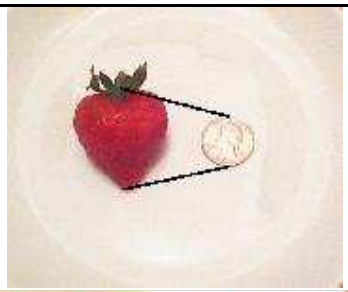
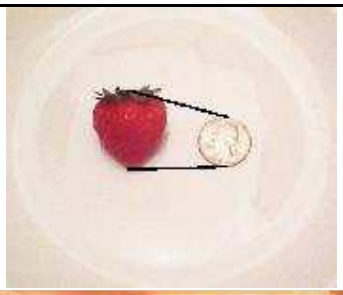
Attributes	Level 1	Level 2
Size	More than 25 g/fruit	Less than 25 g/fruit
Internal color	Ideal red color	Too light or too dark color
External color	Ideal red color	Too light or too dark color
Firmness	Firm	Soft
Flavor (combination of sweetness, sweet/tart balance, and aroma)	Full/intense flavor	Weak/mild flavor
Shelf-life	9 days after harvest	4 days after harvest

Total cost of production/storage/handling	$1.00 /lb	$1.15 /lb

Pictures, shown in Table 4, were used to show the colors and sizes of strawberries for consumer choice experiments. Pictures in Level 1 represent ideal red color of external and internal strawberries. To enhance the illustration in the picture, the size of strawberry was compared to the size of a quarter. Firmness has two levels "Firm" and "Soft." "Intense strawberry flavor" and "Mild strawberry flavor" have been used for the two levels of flavor. Shelf-life was specified as "Will last 9 days at home in your refrigerator" and "Will last 4 days at home in your refrigerator." Lastly, the two levels of Price was set as $2.65 and $2.99, respectively by considering the high and low retail strawberry prices in different seasons (USDA,2013c).

Table 4. Strawberry Attribute Levels in Consumer Choice Scenarios

	Level 1	**Level 2**
External color		

Size		
Internal Color		
Texture	Firm	Soft
Flavor	Intense strawberry flavor	Mild strawberry flavor
Shelf-life at home	Will last 9 days at home in your refrigerator	Will last 4 days at home in your refrigerator
Price	$2.65/lb	$2.99/lb

Participants were presented with a series of choice scenarios. Each scenario contained two alternatives to purchase. The option to choose "Neither" was also included. In the scenarios, each of the two alternatives was characterized by the combination of different levels of fruit attributes. Figure 1 shows an example of the scenarios. Since it was not practical to ask each participant to choose from all possible scenarios, a fractional factorial design was developed to minimize scenario number and maximize profile variation. Each participant in both producer and consumer groups was asked to complete eight choice scenarios.

For this scenario, there will be TWO OPTIONS simulating a situation in which you BUY fruit. You have the opportunity to visually inspect the apple and evaluate the external appearance and size. You can try/eat the apple and evaluate its flesh texture, crispness, and flavor. You know the number of days the apple will last at home in your refrigerator. Price per pound varies for each option presented.

Please indicate which option (only ONE: either Option A or Option B) that best fits your preferences or if you do not like any option, choose "Neither Option A or B"

	Option A	*Option B*	
the External apperance is	*You are in the supermarket and see these apples:* 	*You are in the supermarket and see these apples:* 	*Neither Option A or B*
the Size is	*Less than 3 inch diameter*	*More than 3 inch diameter*	
the Firmness is	*Firm*	*Moderately firm*	
the Crispness is	*Not crisp*	*Very crisp*	
the Flavor is	*Intense apple flavor*	*Mild apple flavor*	
the Shelf-life at home is	*Will last more than 1 week at home in your refrigerator*	*Will last less than 1 week at home in your refrigerator*	
the Price is	*$2.99/lb*	*$1.39/lb*	

Figure 1. Scenario example for apple consumer survey

The choice experiment data was collected through a combination of mail-in and online surveys with producers and online surveys with consumers. In addition to the choice experiment questions, other information regarding consumer purchasing habits and demographics and producers' demographics were also collected. Before

consumers take the survey, they were asked a screening question: “Have you purchased apples (or strawberries) in the past years?” Only those consumers who answered “Yes” to this screening question were allowed to continue and finish the surveys.

The producer sample was provided by various apple and strawberry producer associations and Blue Book Online Services (a credit and marketing information agency serving the international wholesale produce industry). Washington State University Social and Economic Science Research Center used the Dillman’s total design method to collect the producer survey data using the combination of mail-in and online surveys.

Dillman’s total design method has proven effective in increasing survey response rate. The survey package included a cover letter, a booklet questionnaire, postage paid return envelope. One week later a reminder/thank you postcard was sent to all respondents. After two weeks a follow-up reminder including an updated cover letter, the same questionnaire and second postage paid return envelope was sent to non-respondents. A final reminder postcard was sent to non-respondents three weeks later. Two different email reminders were sent to those non-respondents with a valid email address. Every mail and email included the survey URL and a personal access code so that those respondents who like take the survey online could easily access the survey URL.

The apple producer survey data was collected from the producers in the top five apple producing states including Washington, New York, Michigan, Pennsylvania, and California. Appendix A shows the questions we used for this study in the apple producer survey. The strawberry producer survey data was collected from the producers in the top five strawberry producing states including California, Florida,

Oregon, Washington, and Michigan. Similarly, Appendix C shows the questions we used for this study in strawberry producer survey.

Consumer data was collected using online surveys from a representative U.S. consumer sample provided by Qualtrics™, a professional survey company. Qualtrics™ has its own consumer panels for many companies such as Kellogg's and Crate&Barrel. These panels are the core of its online sample. Qualtrics™ also improves its online sample by incorporating participants from online communities, social networks, and websites of all types. Qualtrics™ uses a diversity of motivations to encourage people to take surveys including email invitations, SMS and text messages, telephone alerts, banners and messaging on web sites and online communities.

Appendix B and D show the questions we used for this study in the consumer surveys. Additionally, some ranking questions were used to control data quality. For example, participants were asked to select the top three most important attributes and the three least important attributes from a list and input the corresponding letters into blanks. If they do not input the letters or if they put the same letters for the most important attributes and the least important attributes, they are screened out and cannot continue to finish the survey.

In total, 321 producer surveys out of 1,000 and 801 consumer surveys out of 1,000 were collected for apple. Eighty-six producer surveys out of 300 and 1137 consumer surveys out of 1,500 have been completed for strawberry. Hence, the response rates were 32.1% for apple producer survey and 80.1% for apple consumer survey. For Strawberry, the response rates were 28.7% for producers and 75.8% for consumers. The producer survey data were collected between February and June, 2012 and the consumer survey data were collected in October, 2013.

2.2. *Mixed Logit Model*

Discrete choice models have been widely used by researchers to understand individual choice behavior (Burton et al., 1999; Carpio et al., 2008; Panzone, 2012). McFadden (1974) and Hausmann and McFadden (1984) found that the multinomial logit model has the independence of irrelevant alternatives (IIA) property, which is an unrealistic assumption of actual purchase behavior. In comparison, the mixed logit model relaxes the IIA assumption (Revelt and Train, 1998). The mixed logit model can accommodate the general patterns of competitiveness between choices as well as individual heterogeneity in preferences, which represents more realistic choice-making than can the conditional logit, nested logit, and heteroskedastic extreme value (HEV) models (Train, 2009; Bhat, 2001; Hensher and Greene, 2003). Mixed logit models can also be used to estimate each individual's taste for goods or attributes through simulation (Ouma et al., 2007).

Due to advantages previously described, we used the mixed logit models to analyze the consumer and producer choice experiment data. In the mixed logit model an individual's utility from purchasing/procuring a good is represented by,

$$U_{nj} = \beta_n x_{nj} + \varepsilon_{nj} \quad (1)$$

U_{nj}: individual n's utility from choosing alternative *j;*

x_{nj}: a vector of observed variables representing the characteristics of individual *n* and alternative *j;*

β_n: an unobserved coefficient vector for each *n* and it varies in the population. Its density is $f(\beta|\theta)$, where θ is the true parameters of this distribution;

ε_{nj}: an error term that follows extreme value distribution and is identically and independently distributed. This error term could capture all other factors that are not included in the equation. For example, producers' price expectations are not included and for consumers, their income levels and their taste for different varieties of fruits are not included.

The mixed logit model notations and estimations follow Train (2009). Moreover, Revelt and Train (1998) stated "our data consist of repeated choices within a survey, such that the assumption of β_n constant over choices seems reasonable." and the same assumption was used in our analysis.

The standard logit model can be derived from equation (1). The probability that person *n* select alternative *i* conditional on β is:

$$\mathcal{L}_{ni}(\beta) = \frac{e^{\beta x_{ni}}}{\sum_{j=1}^{J} e^{\beta x_{nj}}} \qquad (2)$$

where $\mathcal{L}$ represents a standard logit function and *J* is the total number of alternatives. Integrating (2) over the density of β, $f(\beta|\theta)$, we can get the unconditional choice probability $\mathcal{P}$ in the mixed logit model.

$$\mathcal{P}_{ni} = \int \mathcal{L}_{ni}(\beta)\ f(\beta|\theta)\ d\beta \qquad (3)$$

Brownstone and Train (1999) studied the probability, (3) and concluded that the $\mathcal{P}$ does not have an IIA property. $\mathcal{P}$ in (3) cannot be integrated analytically because it does not have a closed form in general. The integral needs to be estimated through simulation. Thus, the logit function $\mathcal{L}_{ni}(\beta)$ is estimated by drawing β from $f(\beta|\theta)$.

$$SP_{ni} = \left(\frac{1}{\mathcal{R}}\right) \sum_{r=1}^{\mathcal{R}} \mathcal{L}_{ni}(\beta^r) \qquad (4)$$

where $\mathcal{R}$ is the number of repetitions drawn from $f(\beta|\theta)$ and β^r represents *r*th draw of β. SP_{ni} stands for the simulated probability for an individual's choice of alternative *i*. SP_{ni} has been proved to be an unbiased estimator of P_{ni} by Brownstone and Train (1999). Also, equation (5) shows the simulated log likelihood function after putting the simulated probability into the log-likelihood function.

$$SLL = \sum_{n=1}^{N} \sum_{j=1}^{J} d_{nj} \, ln(SP_{nj}) \quad (5)$$

where d_{nj}=1 if *n* select alternative *j* and 0 otherwise.

In order to derive individual coefficients, we need the probability of the individual's sequence of choices as:

$$P(y_n|x_n, \beta) = \prod_{t=1}^{T} \mathcal{L}_{nt}(y_{nt}|\beta) \quad (6)$$

where y_n is the individual's sequence of chosen alternatives and *t* denotes choice situations. Then individual *n*'s coefficients are calculated as (Train, 2009):

$$\beta_n = \sum_r \beta^r \left(\frac{P(y_n|x_n, \beta^r)}{\sum_r P(y_n|x_n, \beta^r)} \right) \quad (7)$$

After the individual coefficients for each attribute are derived, individual *i*'s WTP for attribute *k* is calculated as follows:

$$WTP_{ik} = -\left(\frac{\beta_{ik}}{\beta_{ic}} \right) \quad (8)$$

where β_{ic} is individual *i*'s coefficient for cost or price.

In this study, we use individual WTP for producers and consumers to construct the supply curves and demand curves for apple attributes and strawberry

attributes. Specifically, after we get producers' WTP values, the retail margins were added to the WTP values (USDA, 2013d) to get the retail supply prices.

We use the farm acreage information collected by the producer survey and the production quantity and acreage information provided by USDA to construct the quantities supplied. According to USDA (USDA, 2013e), about 90 % of the apples produced in the U.S. are produced in the top 5 producing states, which were surveyed in this survey. We use equation (9) to approximate each individual producer's quantity.

$$\begin{aligned} &Quantity\ Supplied\ per\ acre\ for\ apples\ (lbs) = \\ &Average\ quantity\ (lbs)\ per\ acre\ in\ top\ 5\ producing\ states \\ &* \frac{Total\ acres\ in\ top\ 5\ producing\ states}{Total\ acres\ from\ the\ survey} \\ &* \frac{1}{0.90} \end{aligned} \quad (9)$$

U.S. per capita apple consumption data and U.S. population has been used to approximate the quantity demanded for apples as shown in equation (10).

$$\begin{aligned} &Quantity\ Demanded\ per\ consumer\ for\ apples\ (lbs) \\ &= Per\ capita\ consumption\ (lbs) * \frac{U.S.\ population}{The\ number\ of\ participants\ in\ the\ survey} \end{aligned} \quad (10)$$

After we get the approximated quantity supplied for each participant, we rank them according to the associated prices, calculate the total quantity supplied at each price point and then derive the supply curve.

Similarly, with equation (10) we approximate the quantity demanded for each participant, rank them based on the corresponding prices, calculate the total quantity

demanded at each price point and then derive the demand curve. Combining supply and demand curves, we can derive equilibrium price and quantity.

Jacobs et al.(1998) used similar methods to derive the demand curve for the U.S. fish market. They aggregated their sampled participants' individual fish consumption and multiplied by the ratio between U.S. population and the number of survey participants to approximate the U.S. total fish consumption.

A similar process was used to derive the equilibrium price and quantity for strawberries. According to USDA (USDA, 2013e), about 98 % of strawberries were produced in the top 5 producing states. Similar to apples, the quantity for each strawberry attribute is calculated as equation (11) and (12).

$$Quantity\ supplied\ per\ acre\ for\ strawberries\ (lbs) =$$

$$Average\ quantity\ (lbs)\ per\ acre\ in\ each\ produing\ states * \frac{Total\ acres\ in\ top\ 5\ producing\ states}{Total\ acres\ from\ the\ survey} * \frac{1}{0.98} \qquad (11)$$

U.S. per capita strawberry consumption data and U.S. population have been used to approximate the quantity demanded for strawberries as shown in equation (12).

$$Quantity\ Demanded\ per\ consumer\ for\ strawberries\ (lbs) = Per\ capita\ consumption\ (lbs) * \frac{U.S.\ population}{The\ number\ of\ participants\ in\ the\ survey} \qquad (12)$$

When we drive the supply and demand curves, two assumptions were made.

Assumption 1: Fixed Total Quantity Supplied for Apple or Strawberry.

We assume that the per acre production is fixed by using the average production quantity in the top 5 producing states. Then, we multiply the average production by the ratio between the total acres in top 5 producing states and total acres from the survey to approximate total quantity supplied. This assumption allows us to approximate the quantity supplied based on the current apple/strawberry production capacity. It does not consider the possibility that the apple/strawberry cultivar with an improved attribute might lead to increased/decreased productivity or acreage.

Assumption 2: Fixed Total Quantity Demanded for Apples or Strawberries.

We assume the U.S. population and per capita consumption of apples are fixed at the levels when the study is conducted. The U.S. is about 310 million people and we assume that they consume 16 lbs of apples or 8 lbs of strawberries a year on average (USDA 2013a and 2013b). This assumption allows us to approximate total apple demanded based on U.S. consumers' current consumption capacity. However, this assumption does not consider the possibility that the quantity demanded for the apple/strawberry with an improved attribute might increase/decrease.

These two assumptions do not take into account the possible changes in total quantity supplied/demanded brought by new cultivars, but they do allow us to approximate the quantity supplied/demanded for apples/strawberries at their current production/consumption capacities. We made these assumptions based on the fact that many new apple/strawberry cultivars were introduced into the market in the past decades, but we barely see any dramatic change in the total apple/strawberry production/consumption. Additionally, previous studies such as Jacobs et al. (1998) used the same assumptions when they estimate the total U.S. fish consumption.

CHAPTER 3.

RESULTS

3.1. *Apple*

Demographic information from the apple producer survey (Table 5) indicates that the average age of the sampled producers is 59.1 years old, with the majority of them being male. The average education level is somewhere between vocational certificate and 2 year college degree (see Table 5). The average gross annual income from growing apples is between $50,000 and $74,999 and about 25% of their total income comes from the production of apples. The average total acreage the producers own or manage is between 15 and 24 acres. On average, the producers have 25.9 years of experience of production of apples as a farm owner, manager, or primary decision maker. About half of the farms are family or individual operation farms. Approximately 88% of the producers describe their race as Caucasian. According to Census of Agriculture report, the average age for producers is around 59 and about 90 % of them are Caucasians, which is similar to the sampled apple producers' age and race ratio in our study (USDA, 2014).

Table 5. Summary Statistics for Apple Producer Demographic Background Information

Variable	Description	Mean	SD

Age	Participant's age in years	59.1	12.2
Gender	Gender of participant, 1 = male, 2 = female	1.07	0.26
Education	The highest level of education	4.81	2.07
	1 = Some high school or less		
	2 = High school diploma or equivalent		
	3 = Some college, but no degree		
	4 = Vocational or Extension certificate		
	5 = Two-year college degree		
	6 = Four-year college degree		
	7 = Some graduate school		
	8 = Graduate degree		
Income	The gross annual income from participant's apples	3.75	2.58
	1 = Less than $ 25,000		
	2 = $ 25,000-$ 49,999		
	3 = $ 50,000-$ 74,999		
	4 = $ 75,000-$ 99,999		
	5 = $ 100,000-$ 249,999		
	6 = $ 250,000-$ 499,999		
	7 = $ 500,000-$ 999,999		
	8 = $ 1,000,000-$ 2,499,999		
	9 = More than $ 2,500,000		
Income Share	Percentage of participant's total income comes from production of apples	2.96	1.42
	1 = 0%, 2 = 1-25%, 3 = 26-50%, 4 = 51-75%, 5		

	= 76-99%, 6 = 100%		
Acre	Participant's total acre of apples 1 = Less than 5, 2 = 5-14, 3 = 15-24, 4 = 25-49, 5 = 50-99, 6 = 100-249, 7 = 250-499, 8 = 500-1,000, 9 = More than 1,000	3.47	2.08
Experience	Years involved in production of apples as a farm owner, manager, or primary decision maker	25.9	15.1
Structure of Farms	Participant's farm business structures		
	Family or individual operation (excluding partnerships and corporations)	0.53	0.50
	Family partnership	0.13	0.33
	Family corporation	0.24	0.43
	Partnership, other than family	0.025	0.15
	Corporation, other than family	0.019	0.14
	Educational, research, or non-profit farm	0.019	0.14
	Other	0.037	0.17
Race	Participant's race 1 = Caucasian or White, 0 = Other	0.88	0.32

Table 6 shows the summary statistics of demographic background information for apple consumers. The average age of the sampled consumers is between 35 and 44 years old. About 66% of participants are female. The average education level of participants is 2 year college or equivalent. The average annual household income is between $35,000 and $49,999. On average, participants eat apples more than once a week. The average number of apples participants normally buy at one time is 5.25

apples. Participants usually buy apples for 2.75 people, and of the 2.75 people, 1.77 people are under age 18. About 49.6% of participants purchase apples at conventional grocery stores, about 23.3% of participants purchase apples from warehouse retailers. Approximately 11% of participants purchase apples from natural food stores and 11% of them purchase apples from farmers' markets. About 75.5% of participants are Caucasians. The apple consumer sample's demographic background is very similar to U.S. census data except that our sample has a relatively higher proportion of female (U.S. Department of Commerce, Census Bureau, 2014). Previous studies, however, have shown most grocery shoppers are female (Carpenter and Moore, 2006).

Table 6. Summary Statistics for Apple Consumer Demographic Background Information

Variable	Description	Mean	SD
Age	Participant's age in years 1 = 18-24, 2 = 25-34, 3 = 35-44, 4 = 45-54, 5 = 55-64, 6 = 65 or over	3.19	1.56
Gender	Gender of participant, 1 = female, 2 = male	1.34	0.47
Education	The highest level of education 1 = Less than high school 2 = High school degree 3 = 2 year college or technical/other degree 4 = 4 year college degree 5 = Advanced college degree	3.04	1.03
Income	Annual household income of participants	3.34	1.66

	1 = Less than $ 25,000 2 = $ 25,000-$ 34,999 3 = $ 35,000-$ 49,999 4 = $ 50,000-$ 74,999 5 = $ 75,000-$ 99,999 6 = More than $ 100,000		
Frequency	The frequency participant eat fresh apples 1 = Daily 2 = More than once a week 3 = Once a week 4 = 2-3 times a month 5 = Once a month 6 = Less than once a month 7 = Never	2.39	1.27
Number of apples	The number of apple participant bought at one time 1 = 1 apple, 2 = 2, 3 = 3, 4 = 4, 5 = 5, 6 = 6, 7 = 7 or more	5.25	1.68
Number of People	The number of people participants bought apples for 1 = 1, 2 = 2, 3 = 3, 4 = 4, 5 = 5 or more	2.75	1.21
Number of People under Age 18	The number of people under age 18 participants bought apples for 1 = None, 1 = 1, 2 = 2, 3 = 3, 4 = 4 or more	1.77	1.02
Outlet	The outlets participants bought apples from		

	Conventional grocery store (e.g.	0.496	0.500
	Rainbow Foods, Cub Foods, Target,		
	Albertson's, Safeway)	0.107	0.308
	Natural foods grocery stores (e.g.		
	Whole Foods, New Season's,	0.233	0.422
	Byerly's/Lunds)		
	Warehouse retailer (e.g. Costco, Wal-	0.013	0.111
	Mart, Sam's Club)	0.109	0.311
	A Food Co-operative	0.027	0.159
	Farmer's market	0.015	0.121
	Direct Sale (e.g. orchard, farm stand)		
	Other		
Race	Participant's race		
	1 = Caucasian or White, 0 = Other	0.755	0.430

Table 7 shows the mixed logit model estimation results for apple consumers and producers. As expected, the coefficients of *Price* for apple consumer and *Cost* for apple producer variables are negative and significant, indicating that consumers (and producers) regarded price (and cost) as one of the most important attributes when they select apples to buy (produce). As price (cost) of apples increases, the consumer's (or producer's) probability of buying (or producing) apples decreases. The coefficients of *Appearance*, *Crispness*, *Flavor*, and *Shelf-life* are significant at 1% significance level and positive, which means both consumers and producers prefer crispy apples with less defects, with intense flavor and have a longer shelf-life. However, the relative importance of these attributes differs between apple producers and consumers. For

producers, the most important attribute is *Shelf-life*, followed by *Flavor*, *Crispness*, and *Firmness*. In contrast, consumers regard *Crispness* as the most important attribute, followed by *Flavor*, *Appearance*, and *Shelf-life*. Another difference between apple producers and apple consumers is the coefficients for *Firmness* and *Size* are not significant for consumers but they are significant for producers. Interestingly, the coefficient of *Firmness* for consumers indicates consumers prefer moderately firm apples to firm apples. However, the coefficient for *Firmness* is positive and significant for producers, which indicates producers prefer firm apples to moderately firm apples. The results are intuitive because producers prefer attributes that positively impact their revenues, like longer shelf-life and firmness help apples retain their quality during transportation, which is also the basis for price negotiation. Consumers, on the other hand, care most about the eating quality such as crispness and flavor. The standard deviations for the attributes are highly significant for most of the attributes, indicating that there is heterogeneity in consumer and producer preferences for the attributes.

Table 7. Mixed Logit Model Estimation Results for Apple Consumer and Producer Choice Experiment Data

	Apple Producer	**Apple Consumer**
Mean		
Appearance	0.159**	0.273***
	(2.23)	(7.36)

Crispness	0.869***	0.610***
	(9.00)	(15.70)
Firmness	0.368***	-0.015
	(5.60)	(-0.61)
Flavor	1.020***	0.368***
	(9.33)	(7.41)
Size	0.389***	0.02
	(5.47)	(1.15)
Shelf-life	1.082***	0.159***
	(10.40)	(5.75)
Price	----	-0.306***
		(-3.99)
Cost	-2.173***	
	(-5.21)	----
SD		
Appearance	0.178	0.691***
	(1.00)	(15.89)

Crispness	0.523***	0.590***
	(4.74)	(13.94)
Firmness	0.0359	0.0082
	(0.24)	(0.14)
Flavor	1.006***	0.339***
	(7.31)	(0.76)
Size	0.404***	0.022
	(4.05)	(0.43)
Shelf-life	0.526***	0.210***
	(4.51)	(4.08)
Price	----	0.842***
		(15.47)
Cost	4.825***	----
	(9.97)	
Number of Observations	7416	11070

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

As described in the methodology section, the individual coefficient for each estimated attribute can be generated by simulation after the estimation of mixed logit models. Each individual producer and consumer's WTP can be estimated using the individual estimated coefficients for the attributes and equation (8). Table 8 shows the mean values of producer WTP for each apple attribute. Apple producers' average WTP to grow an apple variety with shelf-life more than 1 week is $0.498/lb, with intense flavor is $0.469, and less than 3% defects per lot is $0.073/lb (Table 8). Consumers' average WTP for apples that are crisp is $1.99/lb, and $0.094/lb for sizes larger than 3 inches diameter (Table 9).

Table 8. Apple Producer WTP for Apple Attributes

Attribute	WTP	
	Mean ($)	95% Confidence Intervals
Appearance	0.073	[0.009, 0.137]
Crispness	0.399	[0.252, 0.548]
Firmness	0.169	[0.088, 0.250]
Flavor	0.469	[0.303, 0.634]
Size	0.178	[0.089, 0.268]
Shelf-life	0.498	[0.319, 0.677]
N	321	

Table 9. Apple Consumer WTP for Apple Attributes

Attribute	WTP

	Mean ($)	95% Confidence Intervals
Appearance	0.894	[0.483, 1.305]
Crispness	1.994	[0.921, 3.066]
Firmness	-0.050	[-0.225, 0.124]
Flavor	1.204	[0.352, 2.057]
Size	0.094	[-0.094, 0.283]
Shelf-life	0.522	[0.291, 0.752]
N	801	

After calculating individual producers' WTP, we adjusted these WTP values by the retail margin proportion to obtain the retail supply price. Specifically, according to the retail margin data from USDA (2013d), we multiply the individual producer's WTP by 4.1 to get the retail supply price.

Previous studies have shown the common pricing strategy for agricultural crops is based on production costs. Asci et al. (2014) confirmed that there is positive relationship between the pay price to producers and the production costs by studying greenhouse tomato production expansion in Florida. In other words, producers are willing to pay more in order to produce products with desired attributes. George and King (1971) showed that the production cost is the base to estimate retail prices for the studied food commodities. Specifically, they estimated the retail supply prices by multiplying the production costs by certain ratios. Other research adopted similar methods (cost-plus pricing methods, i.e., adding margins to the production costs) to estimate the retail prices for agricultural products (Wohlgenant, 2001; Li and Sexton,

2009). We adopted similar methods to estimate the retail prices for apple and strawberry based on the production costs.

Once the producer and consumer WTP values are calculated, we approximate the corresponding quantities for the attributes using equations (9) and (10). Then, the supply and demand curves are derived for each attribute. Figure 2 presents the supply and demand curves for each apple attribute. The red dotted lines in Figure 2 are the demand curves and the blue dotted lines are the supply curves for the apple attributes. The consumers' demand curve for apple *Crispness* can be interpreted as how the quantity demanded for very crisp apples (compared to not crisp apples) changes when the price of very crisp apples changes assuming other attributes of the apple are the same. Similarly, the supply curve for *Flavor* represents how producers' quantity supplied for apples with intense flavor changes when the retail price of apples with intense flavor changes assuming other attributes stay the same. The unit for the X-axis is billion pounds and the unit for the Y-axis is U.S. dollars.

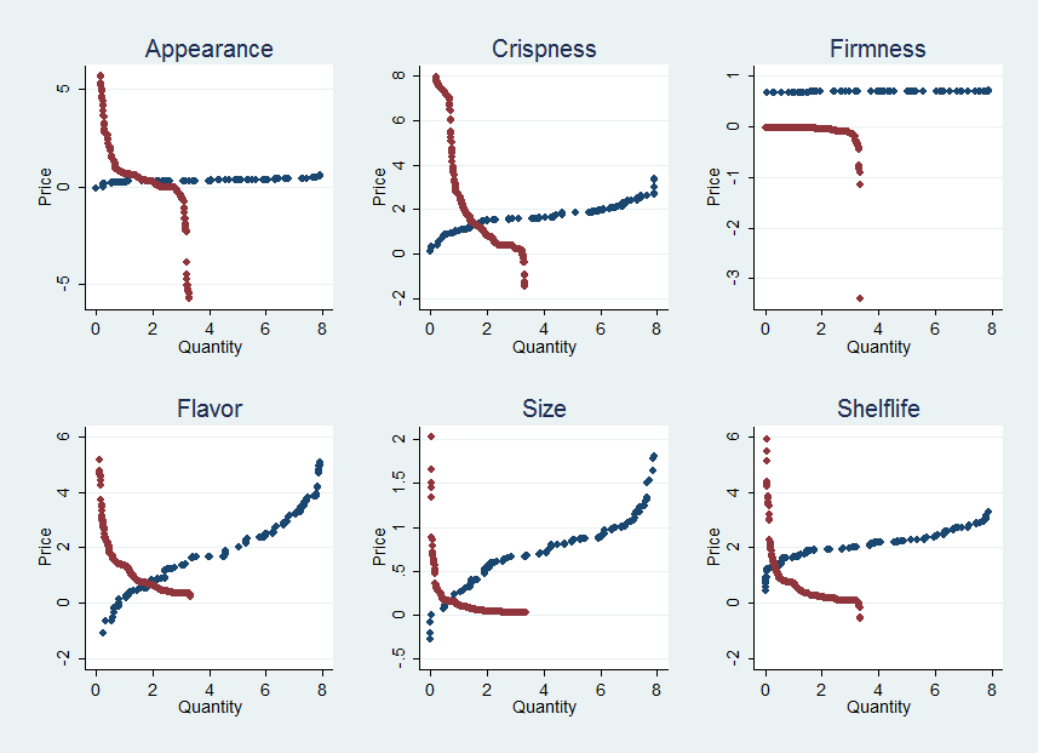


Figure 2. Supply and Demand Curves for Each Apple Attribute

In Figure 2 we observe that the equilibrium exists for all attributes except for *Firmness*. The equilibrium for *Firmness* does not exist for these consumers because most prefer moderately firm apples while most producers prefer firm apples. Supply curves for *Firmness* and *Appearance* show an elastic relationship between quantity and price. The demand curve for *Appearance* looks symmetric at X-axis. Because it is hard to locate the exact equilibrium points using Figure 2, we enlarged the equilibrium areas of the graphs and get Figure 3.

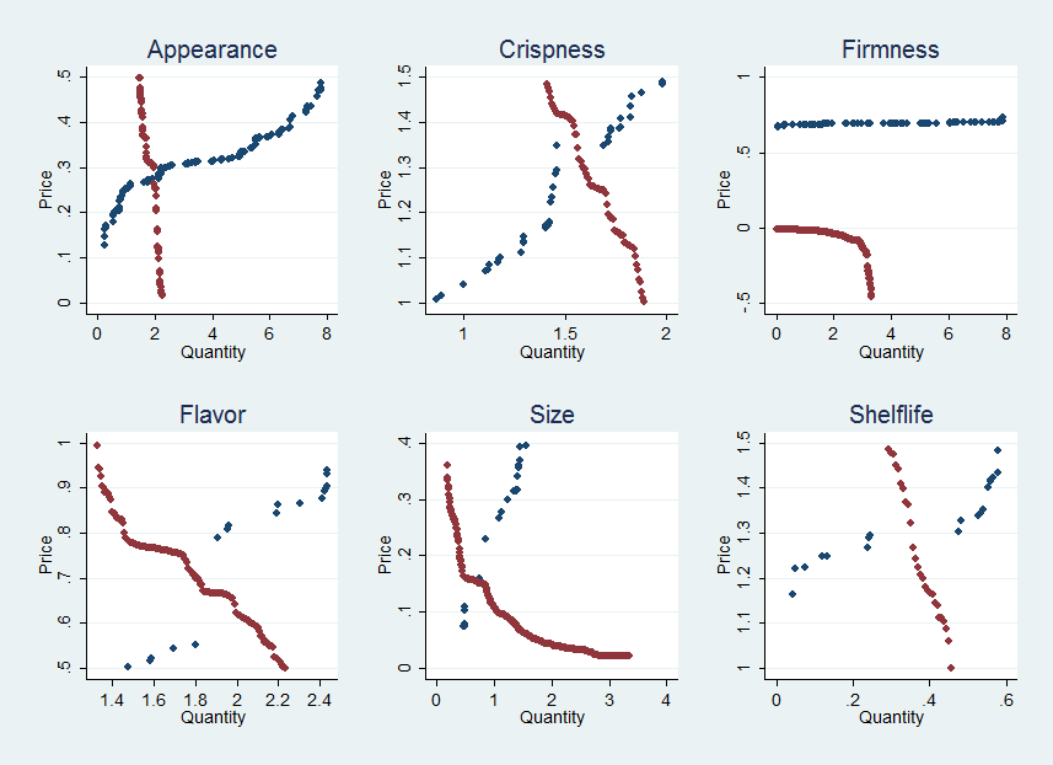


Figure 3. Enlarged Supply and Demand Curves for Each Apple Attribute

Figure 3 shows the equilibriums more clearly. The equilibrium prices for *Crispness* ($1.33/lb) and *Shelf-life* ($1.30/lb) are the highest. The equilibrium price for *Flavor* is $0.68/lb. The equilibrium price for *Appearance* is $0.28/lb. The equilibrium price for *Size* ($0.15/lb) is the lowest. The highest equilibrium quantity is *Appearance*, 2 billion pounds. *Flavor* (1.82 billion pounds), *Crispness* (1.5 billion pounds), and *Size* (0.6 billion pounds) are following. The lowest is *Shelf-life* (0.33 billion pounds).

These equilibrium price and quantity values can be used by breeders to prioritize their breeding target attributes. As we discussed earlier, producers and consumers have different preferences for apple attributes. For instance, producers value *Shelf-life* the most while consumers value *Crispness* the most. Without the market equilibrium price and quantity information, it would be difficult for breeders

to set the priority for the attributes to satisfy both consumers and producers. Once the equilibrium prices are estimated, we find that *Crispness* has the highest equilibrium price, closely followed by *Shelf-life*. *Flavor* ranked third. The two attributes associated with appearance and size exhibited the lowest equilibrium price levels. Apple breeders can adopt the market equilibrium price and quantity information to prioritize their breeding targets.

3.2. *Strawberry*

Table 10 presents the summary statistics of strawberry producer background information. The average age of strawberry producers is 57.2. Most of the sampled strawberry producers are male. The average education level is between vocational certificate and 2 year college degree. The gross annual income of the sampled strawberry producers is between $25,000 and $49,999. On average, about 18% of the producers' total income comes from the production of strawberries. The average acreage is between 5 and 14 acres. The sampled strawberry producers have, on average, 20.9 years of experience working as a farm owner, manager, or primary decision maker. About 63% of the sampled strawberry producers are family or individual operation farms and about 88% of them are Caucasians.

Table 10. Summary Statistics for Strawberry Producer Demographic Background Information

Variable	Description	Mean	SD
Age	Participant's age in years	57.2	12.7

Gender	Gender of participant, 1 = male, 2 = female	1.08	0.27
Education	The highest level of education 1 = Some high school or less 2 = High school diploma or equivalent 3 = Some college, but no degree 4 = Vocational or Extension certificate 5 = Two-year college degree 6 = Four-year college degree 7 = Some graduate school 8 = Graduate degree	4.52	2.12
Income	The gross annual income from participant's strawberries 1 = Less than $ 25,000 2 = $ 25,000-$ 49,999 3 = $ 50,000-$ 74,999 4 = $ 75,000-$ 99,999 5 = $ 100,000-$ 249,999 6 = $ 250,000-$ 499,999 7 = $ 500,000-$ 999,999 8 = $ 1,000,000-$ 2,499,999 9 = More than $ 2,500,000	2.86	2.42
Income Share	Percentage of participant's total income comes from production of strawberries 1 = 0%, 2 = 1-25%, 3 = 26-50%, 4 = 51-75%, 5 = 76-99%, 6 = 100%	2.44	1.11

Acre	Participant's total acre of strawberries 1 = Less than 5, 2 = 5-14, 3 = 15-24, 4 = 25-49, 5 = 50-99, 6 = 100-249, 7 = 250-499, 8 = 500-1,000, 9 = More than 1,000	2.25	1.57
Experience	Years involved in production of strawberries as a farm owner, manager, or primary decision maker	20.9	14.6
Structure of Farms	Participant's farm business structures		
	Family or individual operation (excluding partnerships and corporations)	0.63	0.48
	Family partnership	0.14	0.34
	Family corporation	0.18	0.38
	Partnership, other than family	0.013	0.11
	Corporation, other than family	0.013	0.11
	Educational, research, or non-profit farm	0	0
	Other	0.024	0.15
Race	Participant's race 1 = Caucasian or White, 0 = Other	0.88	0.32

Table 11 shows the consumer participants' demographic background information. The average age of consumer participants is between 35 and 44. Most of them are female (68%). Their average educational level is 2 year college or technical degrees. The average annual household income is between $35,000 and $49,999. On average, they eat fresh strawberries at least once a week. They buy about 2.21 pounds of strawberries at one time for about 2.72 people in their household. On average, there are about two people who are under age 18 in a household. About 36% of strawberry

consumers buy their strawberries in a food co-operative, followed by warehouse retailer (20.7%), conventional grocery store (11.6%), and farmer's market (10.4%). Approximately 72% of participants are Caucasians. Similar to the results for apples, the demographic background for our sample strawberry consumers is very similar to U.S. census data except that our sample has a relatively higher proportion of female (U.S. Department of Commerce, Census Bureau, 2014).

Table 11. Summary Statistics for Strawberry Consumer Demographic Background Information

Variable	Description	Mean	SD
Age	Participant's age in years	3.11	1.55
	1 = 18-24, 2 = 25-34, 3 = 35-44, 4 = 45-54, 5		
	= 55-64, 6 = 65 or over		
Gender	Gender of participant, 1 = female, 2 = male	1.32	0.47
Education	The highest level of education	3.04	1.06
	1 = Less than high school		
	2 = High school degree		
	3 = 2 year college or technical/other degree		
	4 = 4 year college degree		
	5 = Advanced college degree		
Income	Annual household income of participants	3.26	1.65
	1 = Less than $ 25,000		
	2 = $ 25,000-$ 34,999		
	3 = $ 35,000-$ 49,999		

	4 = $ 50,000-$ 74,999 5 = $ 75,000-$ 99,999 6 = More than $ 100,000		
Frequency	The frequency participant eat fresh strawberries 1 = Daily 2 = More than once a week 3 = Once a week 4 = 2-3 times a month 5 = Once a month 6 = Less than once a month 7 = Never	3.24	1.46
Pounds of strawberries	The pounds of strawberries participant bought at one time 1 = 1 pound, 2 = 2, 3 = 3, 4 = 4, 5 = 5, 6 = 6, 7 = 7 or more	2.21	1.28
Number of People	The number of people participants bought strawberries for 1 = 1, 2 = 2, 3 = 3, 4 = 4, 5 = 5 or more	2.72	1.24
Number of People under Age 18	The number of people under age 18 participants bought strawberries for 1 = None, 1 = 1, 2 = 2, 3 = 3, 4 = 4 or more	1.79	1.05
Outlet	The outlets participants bought strawberries from Conventional grocery store (e.g.	0.116	0.316

	Rainbow Foods, Cub Foods, Target, Albertson's, Safeway)	0.087	0.278
	Natural foods grocery stores (e.g. Whole Foods, New Season's, Byerly's/Lunds)	0.207	0.403
	Warehouse retailer (e.g. Costco, Wal-Mart, Sam's Club)	0.359	0.479
	A Food Co-operative	0.104	0.304
	Farmer's market	0.061	0.236
	Direct Sale (e.g. orchard, farm stand)	0.066	0.246
	Other		
Race	Participant's race		
	1 = Caucasian or White, 0 = Other	0.719	0.449

Mixed logit model estimation results for strawberry consumers and producers are shown in Table 12. All coefficients are significant at the 5% significance level. As expected, the coefficients for *Cost* and *Price* are negative and the coefficients for the quality attributes are positive. The coefficients indicate that producers prefer to grow firm strawberries with intense flavor, and ideal external and internal red color. Consumers prefer strawberries with ideal red internal color, with intense flavor, ideal external color, and longer shelf-life. The size of strawberries is the least important attribute for consumers. Similar to the apple results, there is evidence of heterogeneity in consumer and producer preferences for strawberry attributes evidenced by the significance of the standard deviation coefficients.

Table 12. Mixed Logit Model Estimation Results for Strawberry Consumer and Producer Choice Experiment Data

	(1) Producer	(2) Consumer
Mean		
External color	0.689***	0.602***
	(5.87)	(11.82)
Internal color	0.539***	1.050***
	(0.09)	(16.94)
Firmness	0.782***	0.318***
	(4.78)	(4.00)
Flavor	1.336***	0.619***
	(7.43)	(12.47)
Size	0.264***	0.181***
	(3.30)	(4.32)
Shelf-life	0.536***	0.427***
	(3.69)	(9.48)

Cost	-0.969***	
	(-5.99)	
Price		-0.563**
		(-2.18)
SD		
External color	0.635***	0.891***
	(4.22)	(14.02)
Internal color	-0.132	1.244***
	(-0.92)	(17.78)
Firmness	0.619***	0.949***
	(3.61)	(14.63)
Flavor	1.288***	0.859***
	(6.62)	(13.66)
Size	-0.139	0.375***
	(-0.75)	(4.78)
Shelf-life	0.574***	0.648***
	(3.77)	(10.27)
Number of	2016	15916

Observations

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Using the same approach as for apples, the WTP for strawberry attributes were calculated using equation (8). Table 13 shows the mean values of producers' WTP for strawberry attributes. The highest mean WTP value is for *Flavor*, \$1.378/lb. The second and third highest mean WTP values are *Firmness* (\$0.807/lb) and *External color* (\$0.710/lb), respectively. The lowest average WTP value is \$0.272/lb for *Size*. In Table 14, the highest mean WTP value for consumers is for *Internal color*, \$1.866/lb, followed by *Flavor* (\$1.099/lb) and then by *External color* (\$1.069/lb). This means that consumers are willing to pay the highest premium for the ideal internal color, followed by *Flavor* and *External color*. The least mean WTP for strawberry producers is for *Size* (\$0.321/lb)

Table 13. Strawberry Producer WTP for Strawberry Attributes

Attribute	WTP	
	Mean (\$)	95% Confidence Intervals
External color	0.710	[0.466, 0.955]
Internal color	0.556	[0.365, 0.747]
Firmness	0.807	[0.489, 1.124]
Flavor	1.378	[0.966, 1.790]
Size	0.272	[0.111, 0.433]

Shelf-life	0.552	[0.264, 0.841]
N	86	

Table 14. Strawberry Consumer WTP for Strawberry Attributes

Attribute	WTP	
	Mean ($)	95% Confidence Intervals
External color	1.069	[0.178, 1.961]
Internal color	1.866	[0.262, 3.468]
Firmness	0.564	[0.251, 0.877]
Flavor	1.099	[0.027, 2.172]
Size	0.321	[-0.064, 0.707]
Shelf-life	0.759	[-0.006, 1.524]
N	1137	

Using the same method used to derive supply curves for apples, we multiplied the individual producers' WTP by the retail margin proportion, 2.45, to get the retail supply price for strawberries (USDA 2013d). After getting the supply and demand retail prices, we derived supply and demand curves for each attributes. Figure 4 shows supply and demand curves for each strawberry attribute. We enlarge the figures to see the equilibrium prices and quantities more clearly. As shown in Figure 5, the highest equilibrium price is *Internal color*, $1.36, followed by *Flavor* ($1.13), *Firmness* ($1.08) and *External color* ($0.90). The highest equilibrium quantity is *Internal color*, 1.18 billion pounds, followed by *External color* (0.98 billion pounds), *Flavor* (0.93 billion pounds), and *Shelf-life* (0.81 billion pounds).

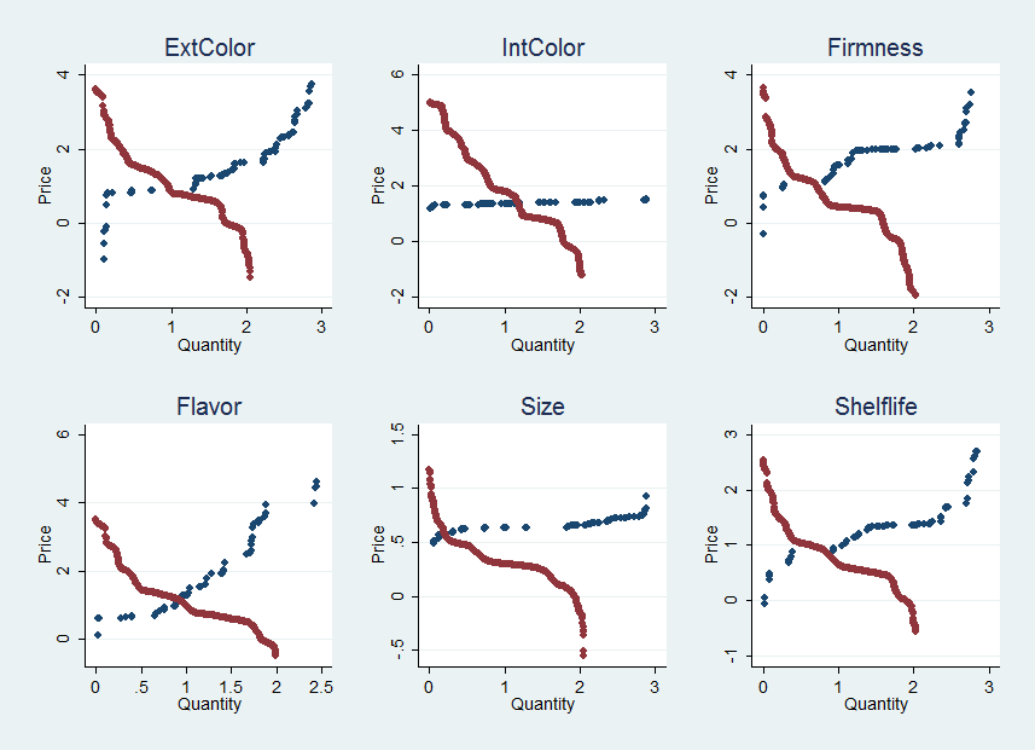


Figure 4. Supply and Demand Curves for Each Strawberry Attribute

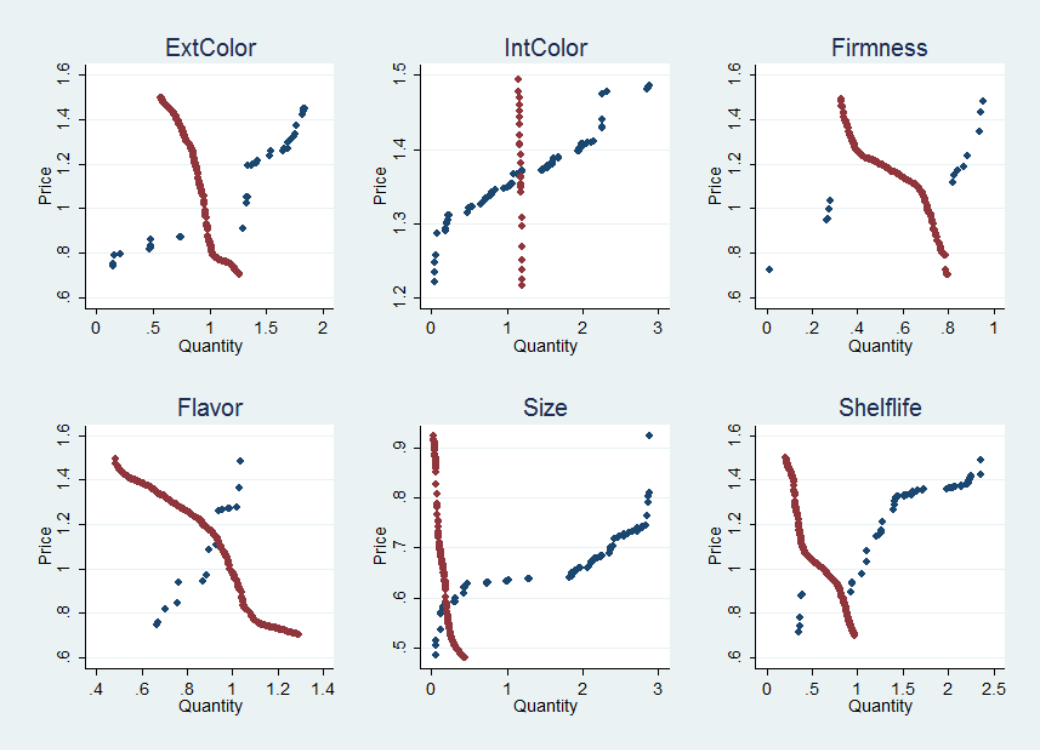


Figure 5. Enlarged Supply and Demand Curves for Each Strawberry Attribute

CHAPTER 4.

WELFARE ANALYSIS

4.1. *Apple*

We calculated the total revenue by multiplying the equilibrium price with the equilibrium quantity for each attribute. Additionally, we calculated the consumer surplus (CS) and producer surplus (PS) to measure the social welfare for apples that have more desirable attributes. The Riemann integral method has been used for approximating CS and PS. The method allows summing all infinitesimal rectangular between equilibrium price and the corresponding curve. The total surplus has been calculated as the sum of CS and PS.

For apple, the highest total revenue is for *Crispness*, two billion dollars, because the equilibrium price and quantity for *Crispness* are high. Although the highest equilibrium quantity is for *Flavor*, 1.82 billion pounds of apples, the total revenue for *Flavor* is only the second highest because its equilibrium price is the third highest. The total revenues for *Appearance* and *Shelf-life* are around 500 million dollars. For *Appearance*, the equilibrium price is pretty low, 28 cents/lb, even though the equilibrium quantity is the highest value among the equilibrium quantities of all apple attributes. Likewise, the total revenue of *Shelf-life* is low because of the low equilibrium quantity. The lowest total revenue for apple attributes is *Size* at 90 million dollars, which is due to its low equilibrium price. The total revenue value for *Firmness* was not calculated because no equilibrium value was found for this attribute.

The consumer surplus for *Crispness* in apples is the highest, at 5.04 billion dollars, followed by *Appearance* ($2.13 billion) and *Flavor* ($1.73 billion). The

highest PS value is for *Flavor* ($1.3 billion) followed by *Crispness* ($0.67 billion) and *Appearance* ($0.14 billion). The demand and supply curves for *Size* and *Shelf-life* are very steep as shown in Figure 2, so their CS and PS values are low. The highest total surplus for apples is for *Crispness*, 5.71 billion dollars, followed by *Flavor* ($3.03 billion), *Appearance* ($2.27 billion), *Shelf-life* ($0.60 billion), and *Size* ($0.20 billion). The ranking of total surplus welfare results is consistent with that of total revenues. In sum, the highest total revenue and total surplus of the apple attributes are for *Crispness* followed by those of *Flavor*, *Appearance*, *Shelf-life*, and *Size*.

Figure 6 presents the demand and supply curves of the "ideal apple" that has the combination of all the more desirable attributes such as better appearance, bigger size, more crispness, solid firmness, intense apple flavor, and longer shelf-life. The equilibrium price and quantity are $4.40/lb and 630 million pounds, respectively, for an ideal apple (Table 15). The total revenue for the ideal apples is 2.77 billion dollars, a little more than that of *Crispness*. However, the total surplus for the ideal apple is a lot less than that of *Crispness*. The CS for the ideal apple is between those of *Appearance* and *Flavor*. The PS for the ideal apple is between *Crispness* and *Appearance*. Thus, although the ideal apple has all good apple attributes mixed into one single apple, the welfare associated with this apple is not significantly higher than that of the very crisp apple. This is because the equilibrium price is so high that the equilibrium quantity is lowered for this ideal apple.

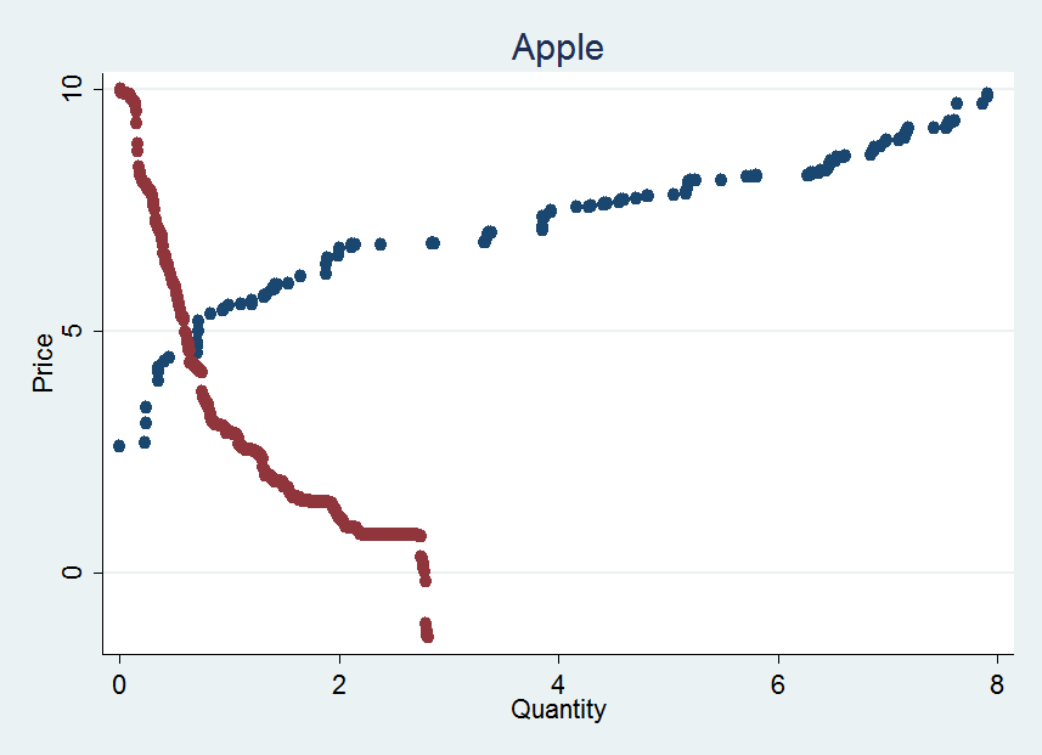


Figure 6. Supply and Demand Curves for Ideal Apple Attributes

Table 15. Welfare Analysis for Apple Attributes*

Apple	Price	Quantity	Total Revenue	Consumer Surplus	Producer Surplus	Total Surplus
Appearance	0.28	2.00	0.56	2.13	0.14	2.27
Crispness	1.33	1.50	2.00	5.04	0.67	5.71
Flavor	0.68	1.82	1.24	1.73	1.30	3.03
Size	0.15	0.60	0.09	0.13	0.07	0.20
Shelf-life	1.30	0.33	0.43	0.54	0.06	0.60
Ideal Apple	4.40	0.63	2.77	1.85	0.51	2.36

*Firmness is not included in the welfare analysis because we did not find the equilibrium values

4.2. *Strawberry*

The welfare analysis for the strawberry attributes was conducted using the same method as for apples. Table 16 shows the estimated welfare results for each strawberry attributes and for the ideal strawberry. The highest total revenue for strawberry attributes is for *Internal color*, $1.60 billion, as both the equilibrium price and quantity for *Internal color* are the highest among the 6 strawberry attributes. The second highest total revenue is *Flavor* ($1.05 billion) and *External color* ($0.88 billion). The total revenues for *Shelf-life* and *Firmness* are almost the same (around $720 million). Although the equilibrium price for *Firmness* is higher than that of *External color* and *Shelf-life*, the total revenue for *Firmness* is less than those of *External color* and *Shelf-life* due to the lower equilibrium quantities. The lowest total revenue is for *Size*, 120 million dollars. This is because the equilibrium price and quantity for size are the lowest values among the strawberry attributes.

The CS and PS were calculated by using demand and supply curves for strawberry attributes. The highest CS value is for *Internal color* ($1.84 billion), but the PS for *Internal color* ($50 million) is ranked 5th because the supply curve is very flat around the equilibrium price. The CS for *External color* is $0.89 billion and the CS for *Flavor* is $0.73 billion. The highest PS for strawberries is for *Flavor* ($0.37 billion), followed by *External color* ($0.22 billion) and *Shelf-life* ($0.16 billion). The highest total surplus is for *Internal color*, 1.89 billion dollars, followed by *External color* ($1.11 billion), *Flavor* ($1.10 billion), *Firmness* ($0.49 billion), and *Shelf-life* ($0.47 billion). The lowest total surplus is for *Size* ($40 million) as the equilibrium price and quantity are both very low. As shown in Table 16, the ranking of total revenue results is similar to that of total surplus for strawberry attributes.

Table 16. Welfare Analysis for Strawberry Attributes

Strawberry	Price	Quantity	Total Revenue	Consumer Surplus	Producer Surplus	Total Surplus
External color	0.9	0.98	0.88	0.89	0.22	1.11
Internal Color	1.36	1.18	1.60	1.84	0.05	1.89
Firmness	1.08	0.67	0.72	0.40	0.09	0.49
Flavor	1.13	0.93	1.05	0.73	0.37	1.10
Size	0.59	0.20	0.12	0.03	0.01	0.04
Shelf-life	0.90	0.81	0.73	0.31	0.16	0.47
Ideal Strawberry	6.40	0.90	5.76	1.26	1.10	2.36

Figure 7 shows supply and demand curves for the "ideal strawberry." The ideal strawberry is the combination of all good strawberry attributes: ideal red external and internal color, solid firmness, intense strawberry flavor, larger size, and longer shelf-life. The equilibrium price for the ideal strawberry is $6.40/lb. The total revenue for the ideal strawberry ($5.76 billion) is much higher than that of each strawberry attribute. The CS, however, for the ideal strawberry is between the CS of *Internal color* and the CS of *External color* because the demand curve for ideal strawberry is flatter than these attributes' demand curves. The PS for the ideal strawberry is large enough to make the total surplus for ideal strawberry higher than other strawberry attributes' total surplus.

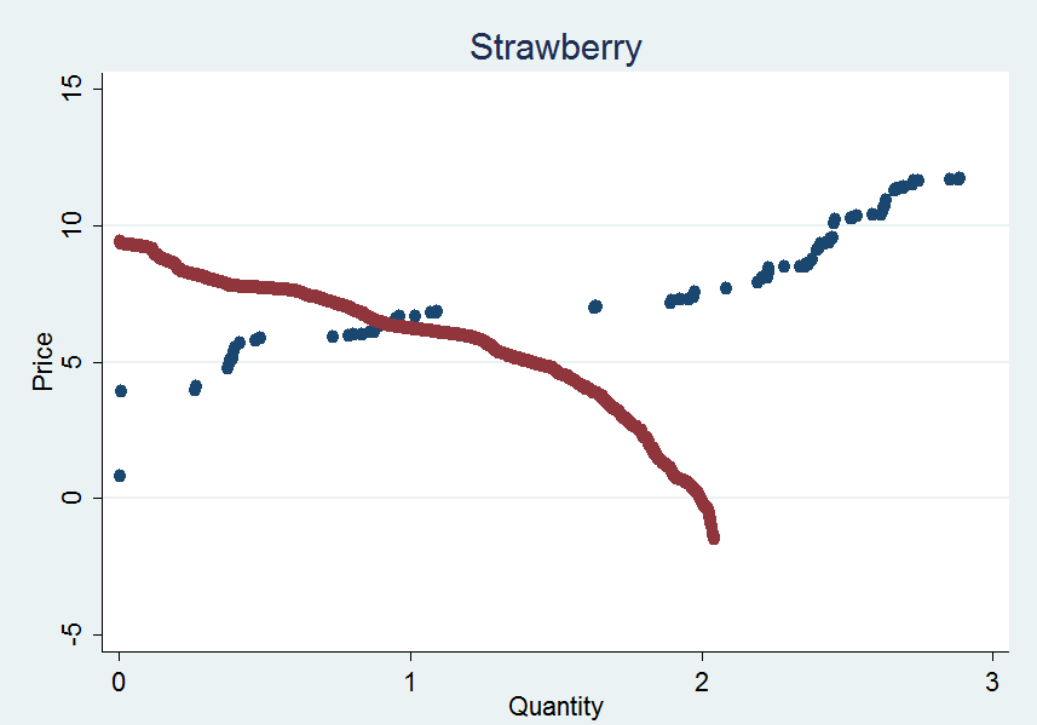


Figure 7. Supply and Demand Curves for Ideal Strawberry Attributes

4.3 Confidence Interval Estimation through Bootstrapping

To construct the confidence intervals for the estimates, we conducted bootstrapping analysis. We used bootstrapping to randomly select observations from the raw data and run the whole analysis for 500 times. Then, the 500 estimates were ranked from the highest to the lowest, the 13th lowest estimate was used to approximate the lower end of the 95% confidence interval and the 12th highest estimate was used to approximate the upper end of the 95% confidence interval. This process was used to construct the confidence intervals for the equilibrium prices, equilibrium quantities, and welfare estimates.

Table 17 shows the 95% confidence intervals for apple estimates. If the confidence intervals overlap, it means the two attributes do not significantly differ in

terms of equilibrium prices, equilibrium quantities, or the welfare measures. The *Crispness* and *Shelf-life*'s 95% confidence intervals for equilibrium prices overlap each other, which means these two attributes' equilibrium prices do not significantly differ from each other. The confidence intervals of equilibrium quantities for *Crispness*, *Flavor*, and *Shelf-life* overlap. The confidence intervals for the total revenues overlap for *Appearance*, and *Flavor*, *Shelflife* and *Appearance*, and *Crispness* and *Flavor*. For consumer surplus, the confidence intervals for *Appearance* and *Flavor* overlap slightly while for producer surplus, the confidence intervals for *Size* and *Shelf-life* overlap. However, for total surplus, none of the confidence intervals overlap each other.

Table 17. Bootstrapping Results for Apple Attributes

Apple	Price	Quantity	Total Revenue	Consumer Surplus	Producer Surplus	Total Surplus
Appearance	[0.20, 0.37]	[1.81, 2.21]	[0.36, 0.82]	[1.97, 2.31]	[0.12, 0.17]	[2.09, 2.48]
Crispness	[0.97, 1.93]	[1.11, 2.27]	[1.07, 4.38]	[4.23, 5.86]	[0.57, 0.78]	[4.80, 6.64]
Flavor	[0.46, 0.92]	[1.59, 2.09]	[0.73, 1.93]	[1.52, 1.99]	[1.20, 1.42]	[2.72, 3.41]
Size	[0.13, 0.16]	[0.57, 0.62]	[0.07, 0.10]	[0.12, 0.14]	[0.07, 0.07]	[0.19, 0.21]
Shelf-life	[1.09, 1.54]	[0.22, 0.42]	[0.23, 0.65]	[0.39, 0.81]	[0.05, 0.08]	[0.44, 0.89]
Ideal Apple	[3.78, 5.21]	[0.42, 0.79]	[1.58, 4.12]	[1.54, 2.21]	[0.39, 0.65]	[1.93, 2.86]

Table 18 shows the 95% confidence intervals for strawberry equilibrium price, quantity, and welfare estimates. The 95% confidence intervals for equilibrium price

overlap each other for *External color*, *Firmness*, *Flavor*, and *Shelf-life*. As we can see in Table 16, these equilibrium prices are very similar. For the confidence intervals for equilibrium quantities, *External color and Flavor*, and *Firmness* and *Shelf-life* overlap each other. The confidence intervals of the total revenues overlap for *External color*, *Firmness*, *Flavor*, and *Shelf-life*. In addition, the confidence intervals of *External color and Flavor* overlap for the consumer surplus. *Firmness* and *Shelf-life*'s confidence intervals for producer surplus slightly overlap. The confidence intervals for the total surplus for *External color and Flavor*, and *Firmness* and *Shelf-life* overlap each other.

Table 18. Bootstrapping Results for Strawberry Attributes

Strawberry	Price	Quantity	Total Revenue	Consumer Surplus	Producer Surplus	Total Surplus
External color	[0.78, 1.15]	[0.85, 1.09]	[0.66, 1.25]	[0.72, 1.01]	[0.17, 0.27]	[0.89, 1.28]
Internal color	[1.21, 1.71]	[1.02, 1.44]	[1.23, 2.46]	[1.51, 2.24]	[0.04, 0.06]	[1.55, 2.30]
Firmness	[0.85, 1.23]	[0.51, 0.81]	[0.43, 0.99]	[0.34, 0.50]	[0.08, 0.12]	[0.42, 0.62]
Flavor	[0.81, 1.28]	[0.83, 1.16]	[0.67, 1.48]	[0.64, 0.85]	[0.33, 0.42]	[0.97, 1.27]
Size	[0.56, 0.61]	[0.17, 0.22]	[0.10, 0.13]	[0.03, 0.04]	[0.01, 0.01]	[0.04, 0.05]
Shelf-life	[0.75, 1.08]	[0.67, 0.86]	[0.50, 0.92]	[0.24, 0.35]	[0.13, 0.18]	[0.37, 0.53]
Ideal Strawberry	[5.41, 7.38]	[0.78, 1.09]	[4.22, 8.04]	[1.15, 1.46]	[0.96, 1.22]	[2.11, 2.68]

CHAPTER 5.

DISCUSSION AND CONCLUSIONS

Fresh apples and strawberries are the 2nd and 3rd most consumed fruits in the U.S. following bananas (USDA, 2013f). The U.S. annual per capita consumption of apples and strawberries are 16 pounds and 8 pounds, respectively (USDA, 2013a and 2013b). In 2012, approximately 4.8 billion pounds of fresh apples and 2.4 billion pounds of fresh strawberries were purchased by U.S. consumers. In 2012, the apple and strawberry industries had revenues of 3.08 billion dollars and 2.41 billion dollars, respectively (USDA, 2013g). In order to maintain the sustainability of the industries, apple and strawberry breeders are investing human and financial resources to breed new cultivars. To make good use of resources, trait prioritization is of great importance to breeders so that they can make sure the new cultivars can achieve market success.

Most previous studies on preferences for fruit attributes only focused on one party, either consumers or producers (McClusky et al., 2013; Skreli and Imami, 2012; Colquhoun et al., 2012). To our knowledge, there is no research to synthesize the information from the different parties. Our study is the first attempt to tackle this issue. We investigate consumer and producer preferences and WTP for apple and strawberry attributes. Furthermore, we derived the supply and demand curves and found the equilibrium price and quantity for each fruit attribute. We also conducted welfare analysis for each fruit attribute based on the derived supply and demand curves.

Previous studies on apple consumers have found that consumers preferred crispness, sweetness, tartness, firmness, and juiciness (Yue and Tong, 2011; McClusky et al., 2007 and 2013; Peneau et al., 2006). Our study confirmed that apple

consumers regard crispness and flavor as more important than other apple attributes. Our results show that consumers do not consider apple firmness as important, which differs from the findings by McCluskey et al. (2007 and 2013) who found that firmness is important for consumers who purchase Gala or Red Delicious apples. Yue et al. (2013 and 2014) found flavor and crispness are important for apple producers, and firmness, flavor, and shelf-life are important for strawberry producers. This study confirms flavor had high values for apple producers and flavor and firmness had high values for strawberry producers. After combining producer and consumer preferences and finding the market equilibrium values for the attributes, we found *Crispness* and *Shelf-life* have the highest value among the tested apple attributes, a finding which differs from most previous consumer apple studies' results.

Recent research on consumer preferences for strawberry attributes has found that consumers prefer sweeter or firmer strawberry fruit (Keutgen and Palwelzik, 2007; Lado et al., 2010; Colquhoun et al., 2012). Our study reached a similar conclusion. After considering both consumer and producer preferences for strawberry attributes, *Flavor* and *Internal color* have the highest market values among the studied strawberry attributes, a finding which is not quite the same as findings of previous studies on consumer preferences for strawberry attributes.

Based on our results for both apples and strawberries, we conclude that the attributes with the highest values are different when we consider both consumer and producer preferences than when we only consider consumer preferences. Therefore, ignoring producers' preferences and focusing on consumer preferences alone only generates partial information about the market value of fruit attributes.

Our main empirical findings are as follows. Apple producers prefer apples to have longer shelf-life, intense apple flavor, and high crispness while consumers prefer apples with high crispness, intense apple flavor, and good appearance. Based on the supply and demand curves, the highest apple equilibrium price is for *Crispness* ($1.33), followed by *Shelf-life* ($1.30), *Flavor* ($0.68), *Appearance* ($0.28), and *Size* ($0.15). The highest total revenue for apples is for *Crispness* ($2 billion), followed by *Flavor* ($1.24 billion), *Appearance* ($0.56 billion), *Shelf-life* ($0.43 billion), and *Size* ($0.09 billion). We found the equilibrium price for an ideal apple is $4.40/lb and the equilibrium quantity is 0.63 billion pounds. The total revenue for the ideal apple ($2.77 billion) is greater than each individual apple attribute's total revenues; however, the total surplus ($2.36 billion) for the ideal apple is less than that of for the individual attributes of *Crispness* and *Flavor*.

Strawberry producers prefer strawberries to have intense strawberry flavor, firmness, and ideal red external color. Consumers prefer strawberries to have ideal red internal and external color and intense strawberry flavor. The highest equilibrium price for strawberries is *Internal color* ($1.36), followed by *Flavor* ($1.13), *Firmness* ($1.08), *External color* ($0.90), *Shelf-life* ($0.90), and *Size* ($0.59). The highest total revenue for strawberry attributes is *Internal color* ($1.60 billion), followed by *Flavor* ($1.05 billion), *External color* ($0.88 billion), *Shelf-life* ($0.73 billion), *Firmness* ($0.72 billion), and *Size* ($0.12 billion). The ranking of attributes based on total surplus is somewhat different from that based on total revenue. The highest total surplus is for the attribute *Internal color* ($1.89 billion), followed by *External color* ($1.11 billion), *Flavor* ($1.10 billion), *Firmness* ($0.49 billion), *Shelf-life* ($0.47 billion), and *Size* ($0.04 billion). The equilibrium price and quantity for the ideal strawberry are $6.40/lb and 0.90 billion pounds. The welfare value for the ideal

strawberry is greater than that of any individual strawberry attributes. The total revenue for the ideal strawberry is 5.76 billion dollars and the total surplus is 2.36 billion dollars.

Bootstrapping analysis has been conducted to estimate the 95% confidence intervals for the equilibrium prices, equilibrium quantities and welfare measures. There are two welfare measures breeders can make use of when they prioritize fruit traits in breeding: total revenue and total surplus. On the one hand, revenue oriented breeders such as breeders in the private sectors can focus on total revenue when they develop new cultivars. On the other hand, breeders in public sectors such as breeders at research centers or universities can focus on total surplus so that the new cultivars can attain the highest social welfare.

Therefore, private sector apple breeders who focus on total revenues should put the highest priority on *Crispness*. *Flavor* and *Appearance* rank 2nd and should be given the same priority. For private strawberry breeders, *Internal color* should be given the highest priority, and *Flavor* and *External color* are equally important and rank 2nd. Public sector apple breeders should give the highest priority to *Crispness*. *Flavor* ranks 2nd, and *Appearance* ranks 3rd. Similar to private sector strawberry breeders, public sector strawberry breeders can give the highest priority to *Internal color*, and *External color* and *Flavor* are of equal importance and rank 2nd.

The equilibrium prices and quantities for fruit attributes provide useful information to fruit breeders when they develop new fruit cultivars. If producers and consumers had the same preferences for fruit attributes, it would be easier for breeders to prioritize fruit traits in their breeding programs. However, producers and consumers might have different preferences, and place different weights on fruit

attributes or even have opposite preferences. In such a case, incorporating WTP data from both parties into a breeder's analysis can be challenging. Giving weights to the WTP results for each party can be done but the weights are arbitrary. By estimating the equilibrium prices and quantities, total revenue, and total surplus for each fruit attribute, we successfully synthesize information about producer and consumer's WTP. Our results provide important information to breeders about what attributes would generate the highest total revenue or social surplus so that they can allocate their resources accordingly to focus on the improvement of these attributes.

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APPENDIX A: Example Questions in Apple Producer Survey

1. **For the following questions, think about a potential apple variety you might grow for the "MAJOR USE" (fresh or processed). You will be presented eight different scenarios. For each scenario, there will be TWO OPTIONS simulating a situation in which you grow a potential apple variety with different combinations of fruit attributes and hypothetical total cost for production and handling. Please indicate which option A or B (only ONE) you prefer to grow at the SPECIFIED Total Cost or choose "Neither Option" if you do not like Option A or B. (*Please note these scenarios are simulated and might not reflect the current real situation on your farm/operation; but please answer these questions assuming you are now given these two options and let us know which option you would choose*).**

APPLE Scenario 1: *Check the box corresponding to the option you would choose.*

Attribute	***Option A:***	***Option B:***	***Option C:***
External appearance-Free from defects	Less than 3% defects per lot	More than 3% defects per lot	
Crispness	Not crisp	Very crisp	
Firmness	More than 14 lbs	Less than 14 lbs	
Flavor (Combination of sweetness, sweet/tart balance and aroma	Full/intense flavor	Weak/mild flavor	Neither Option
Size	Less than 2.9 inches (100 count)	More than 2.9 inches (100 count)	
Shelf life at retail	Good (More than 1 week)	Poor (Less than 1 week)	
Total cost of production/storage/handling	$24 /carton (42 lbs)	$12 /carton (42 lbs)	
Which option would you choose?	☐	☐	☐

APPLE Scenario 2: *Check the box corresponding to the option you would choose.*

Attribute	***Option A:***	***Option B:***	***Option C:***
External appearance-Free from defects	Less than 3% defects per lot	More than 3% defects per lot	
Crispness	Not crisp	Very crisp	
Firmness	Less than 14 lbs	More than 14 lbs	
Flavor (Combination of sweetness, sweet/tart balance and aroma)	Weak/mild flavor	Full/intense flavor	Neither Option
Size	Less than 2.9 inches (100 count)	More than 2.9 inches (100 count)	
Shelf life at retail	Poor (Less than 1 week)	Good (More than 1 week)	
Total cost of	$12 /carton (42 lbs)	$24 /carton (42 lbs)	

production/storage/handling			
Which option would you choose?	☐	☐	☐

APPLE Scenario 3: *Check the box corresponding to the option you would choose.*

Attribute	***Option A:***	***Option B:***	***Option C:***
External appearance-Free from defects	More than 3% defects per lot	Less than 3% defects per lot	
Crispness	Not crisp	Very crisp	
Firmness	More than 14 lbs	Less than 14 lbs	
Flavor (Combination of sweetness, sweet/tart balance and aroma)	Weak/mild flavor	Full/intense flavor	Neither Option
Size	More than 2.9 inches (100 count)	Less than 2.9 inches (100 count)	
Shelf life at retail	Good (More than 1 week)	Poor (Less than 1 week)	
Total cost of production/storage/handling	$12 /carton (42 lbs)	$24 /carton (42 lbs)	
Which option would you choose?	☐	☐	☐

APPLE Scenario 4: *Check the box corresponding to the option you would choose.*

Attribute	***Option A:***	***Option B:***	***Option C:***
External appearance-Free from defects	Less than 3% defects per lot	More than 3% defects per lot	
Crispness	Not crisp	Very crisp	
Firmness	Less than 14 lbs	More than 14 lbs	
Flavor (Combination of sweetness, sweet/tart balance and aroma)	Full/intense flavor	Weak/mild flavor	Neither Option
Size	More than 2.9 inches (100 count)	Less than 2.9 inches (100 count)	
Shelf life at retail	Good (More than 1 week)	Poor (Less than 1 week)	
Total cost of production/storage/handling	$24 /carton (42 lbs)	$12 /carton (42 lbs)	
Which option would you choose?	☐	☐	☐

APPLE Scenario 5: *Check the box corresponding to the option you would choose.*

Attribute	***Option A:***	***Option B:***	***Option C:***
External appearance-Free from defects	More than 3% defects per lot	Less than 3% defects per lot	Neither Option
Crispness	Not crisp	Very crisp	

Firmness	More than 14 lbs	Less than 14 lbs	
Flavor (Combination of sweetness, sweet/tart balance and aroma	Full/intense flavor	Weak/mild flavor	
Size	Less than 2.9 inches (100 count)	More than 2.9 inches (100 count)	
Shelf life at retail	Poor (Less than 1 week)	Good (More than 1 week)	
Total cost of production/storage/handling	$12 /carton (42 lbs)	$24 /carton (42 lbs)	
Which option would you choose?	☐	☐	☐

APPLE-Scenario 6: *Check the box corresponding to the option you would choose.*

Attribute	***Option A:***	***Option B:***	***Option C:***
External appearance-Free from defects	Less than 3% defects per lot	More than 3% defects per lot	
Crispness	Very crisp	Not crisp	
Firmness	More than 14 lbs	Less than 14 lbs	
Flavor (Combination of sweetness, sweet/tart balance and aroma	Full/intense flavor	Weak/mild flavor	Neither Option
Size	More than 2.9 inches (100 count)	Less than 2.9 inches (100 count)	
Shelf life at retail	Poor (Less than 1 week)	Good (More than 1 week)	
Total cost of production/storage/handling	$24 /carton (42 lbs)	$12 /carton (42 lbs)	
Which option would you choose?	☐	☐	☐

APPLE Scenario 7: *Check the box corresponding to the option you would choose.*

Attribute	***Option A:***	***Option B:***	***Option C:***
External appearance-Free from defects	Less than 3% defects per lot	More than 3% defects per lot	
Crispness	Not crisp	Very crisp	
Firmness	More than 14 lbs	Less than 14 lbs	
Flavor (Combination of sweetness, sweet/tart balance and aroma	Weak/mild flavor	Full/intense flavor	Neither Option
Size	More than 2.9 inches (100 count)	Less than 2.9 inches (100 count)	
Shelf life at retail	Poor (Less than 1 week)	Good (More than 1 week)	
Total cost of production/storage/handling	$12 /carton (42 lbs)	$24 /carton (42 lbs)	
Which option would you choose?	☐	☐	☐

APPLE Scenario 8: *Check the box corresponding to the option you would choose.*

Attribute	*Option A:*	*Option B:*	*Option C:*
External appearance-Free from defects	Less than 3% defects per lot	More than 3% defects per lot	
Crispness	Very crisp	Not crisp	
Firmness	More than 14 lbs	Less than 14 lbs	
Flavor (Combination of sweetness, sweet/tart balance and aroma	Weak/mild flavor	Full/intense flavor	Neither Option
Size	Less than 2.9 inches (100 count)	More than 2.9 inches (100 count)	
Shelf life at retail	Good (More than 1 week)	Poor (Less than 1 week)	
Total cost of production/storage/handling	$24 /carton (42 lbs)	$12 /carton (42 lbs)	
Which option would you choose?	☐	☐	☐

PLEASE TELL US ABOUT YOUR OPERATION

2. How many total acres of apple orchard/farm do you own or manage? (*Check only one category.*)

- ❑ < 5
- ❑ 5 to 14
- ❑ 15 to 24
- ❑ 25 to 49
- ❑ 50 to 99
- ❑ 100 to 249
- ❑ 250 to 499
- ❑ 500 to 1,000
- ❑ > 1,000

2a. Which of the following tree training systems are used on this orchard? ***(Please check all that apply.)***

- □ High density, angled, planar (2D)
- □ High density, vertical, planar, (2D)
- □ Low density (3D-central leader, vertical axis, open vase, open center)
- □ Other *(Please specify)*:_____ _____

3. In what zip code (or zip codes) are your apple orchard/farms located?

_____

4. Which of the following business structures best describes your apple orchard/farm operation? (*Check only one category.*)

- ❑ Family or individual operation (excluding partnerships and corporations)
- ❑ Family partnership
- ❑ Family corporation
- ❑ Partnership, other than family
- ❑ Corporation, other than family
- ❑ Educational, research, or non-profit farm
- ❑ Other *please explain*:_____

5. Which of the following categories best represents the 2010 growing season gross income from ALL your apple orchards/farms? (*Check only one category.*)

- ❑ < $25,000
- ❑ $25,000 - $49,999
- ❑ $50,000 - $74,999
- ❑ $75,000 - $99,999
- ❑ $100,000 - $249,999
- ❑ $250,000 - $499,999
- ❑ $500,000 - $999,999
- ❑ $1,000,000 - $2,499,999
- ❑ > $2,500,000

6. **Approximately what percentage of your total household income comes from ALL your apple orchard/farm operation**?

❑ 0% ❑ 1–25% ❑ 26–50% ❑ 51–75%
❑ 76–99% ❑ 100%

7. **What percentage of your apple <u>acres</u> was covered under a crop insurance policy in the 2010 growing season?**
_____ % or ❑ <u>None</u>

PLEASE TELL US ABOUT YOURSELF

8. **Are you male or female?**

❑ Male ❑ Female

9. **How old are you?** _____ years old.

10. **For how many years have you been involved in apple production as an orchard owner, manager, or primary decision maker?**

_____ years

11. **Which of the following categories best describes your ethnic and racial background? (*Please check all that apply.*)**

❑ Caucasian or White
❑ Spanish, Hispanic, or Latino
❑ Black or African American
❑ American Indian or Alaska Native
❑ Asian, Asian American, or Pacific Islander
❑ Other: _____

12. **What is the highest level of formal education that you have completed? (*Please check the one answer that best applies.*)**

❑ Some high school or less
❑ High school diploma or equivalent

- ❑ Some college, but no degree
- ❑ Vocational or Extension certificate
- ❑ Two-year college degree
- ❑ Four-year college degree
- ❑ Some graduate school
- ❑ Graduate degree

IF YOU HAVE ANY ADDITIONAL COMMENTS YOU WOULD LIKE TO SHARE WITH US, PLEASE WRITE THEM IN THE SPACE BELOW.

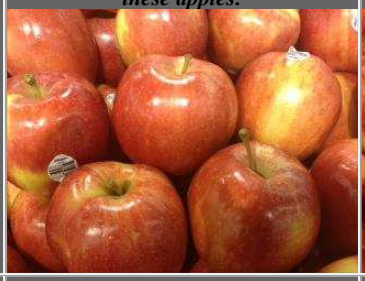
APPENDIX B: Example Questions in Apple Consumer Survey

For the following questions, you will be presented with eight different scenarios. For each scenario,there will be TWO OPTIONS simulating a situation in which you BUY fruit. Please indicate which option (only ONE) best fits your preferences or choose "Neither Option" if you do not like Option A or B.

Scenario 1

For this scenario, there will be TWO OPTIONS simulating a situation in which you BUY fruit. You have the opportunity to visually inspect the apple and evaluate the external appearance and size. You can try/eat the apple and evaluate its flesh texture, crispness, and flavor. You know the number of days the apple will last at home in your refrigerator. Price per pound varies for each option presented.

Please indicate which option (only ONE: either Option A or Option B) that best fits your preferences or if you do not like any option, choose "Neither Option A or B"

	Option A	*Option B*	*Neither Option A or B*
the External apperance is	*You are in the supermarket and see these apples:* 	*You are in the supermarket and see these apples:* 	*Neither Option A or B*
the Size is	*Less than 3 inch diameter*	*More than 3 inch diameter*	
the Firmness is	*Firm*	*Moderately firm*	
the Crispness is	*Not crisp*	*Very crisp*	
the Flavor is	*Intense apple flavor*	*Mild apple flavor*	
the Shelf life at home is	*Will last more than 1 week at home in your refrigerator*	*Will last less than 1 week at home in your refrigerator*	
the Price is	*$2.99/lb*	*$1.39/lb*	

Scenario 2

For this scenario, there will be TWO OPTIONS simulating a situation in which you BUY fruit. You have the opportunity to visually inspect the apple and evaluate the external appearance and size. You can try/eat the apple and evaluate its flesh texture, crispness, and flavor. You know the number of days the apple will last at home in your refrigerator. Price per pound varies for each option presented.

Please indicate which option (only ONE: either Option A or Option B) that best fits your preferences or if you do not like any option, choose "Neither Option A or B"

	Option A	*Option B*	*Neither Option A or B*
the External apperance is	*You are in the supermarket and see these apples:* 	*You are in the supermarket and see these apples:* 	*Neither Option A or B*
the Size is	*Less than 3 inch diameter*	*More than 3 inch diameter*	
the Firmness is	*Moderately Firm*	*Firm*	
the Crispness is	*Not crisp*	*Very crisp*	
the Flavor is	*Mild apple flavor*	*Intense apple flavor*	
the Shelf life at home is	*Will last less than 1 week at home in your refrigerator*	*Will last more than 1 week at home in your refrigerator*	
the Price is	*$2.99/lb*	*$1.39/lb*	

Scenario 3

For this scenario, there will be TWO OPTIONS simulating a situation in which you BUY fruit. You have the opportunity to visually inspect the apple and evaluate the external appearance and size. You can try/eat the apple and evaluate its flesh texture, crispness, and flavor. You know the number of days the apple will last at home in your refrigerator. Price per pound varies for each option presented.

Please indicate which option (only ONE: either Option A or Option B) that best fits your preferences or if you do not like any option, choose "Neither Option A or B"

	Option A	*Option B*	*Neither Option A or B*
the External apperance is	*You are in the supermarket and see these apples:* 	*You are in the supermarket and see these apples:* 	*Neither Option A or B*
the Size is	*More than 3 inch diameter*	*Less than 3 inch diameter*	
the Firmness is	*Firm*	*Moderately firm*	

the Crispness is	*Not crisp*	*Very crisp*	
the Flavor is	*Mild apple flavor*	*Intense apple flavor*	
the Shelf life at home is	*Will last more than 1 week at home in your refrigerator*	*Will last less than 1 week at home in your refrigerator*	
the Price is	*$2.99/lb*	*$1.39/lb*	

Scenario 4

For this scenario, there will be TWO OPTIONS simulating a situation in which you BUY fruit. You have the opportunity to visually inspect the apple and evaluate the external appearance and size. You can try/eat the apple and evaluate its flesh texture, crispness, and flavor. You know the number of days the apple will last at home in your refrigerator. Price per pound varies for each option presented.

Please indicate which option (only ONE: either Option A or Option B) that best fits your preferences or if you do not like any option, choose "Neither Option A or B"

	Option A	*Option B*	*Neither Option A or B*
the External apperance is	*You are in the supermarket and see these apples:* 	*You are in the supermarket and see these apples:* 	
the Size is	*More than 3 inch diameter*	*Less than 3 inch diameter*	*Neither Option A or B*
the Firmness is	*Moderately firm*	*Firm*	
the Crispness is	*Not crisp*	*Very crisp*	
the Flavor is	*Intense apple flavor*	*Mild apple flavor*	
the Shelf life at home is	*Will last more than 1 week at home in your refrigerator*	*Will last less than 1 week at home in your refrigerator*	
the Price is	*$1.39/lb*	*$2.99/lb*	

Scenario 5

For this scenario, there will be TWO OPTIONS simulating a situation in which you BUY fruit. You have the opportunity to visually inspect the apple and evaluate the external appearance and size. You can try/eat the apple and evaluate its flesh texture, crispness, and flavor. You know the number of days

the apple will last at home in your refrigerator. Price per pound varies for each option presented.

Please indicate which option (only ONE: either Option A or Option B) that best fits your preferences or if you do not like any option, choose "Neither Option A or B"

	Option A	*Option B*	*Neither Option A or B*
the External apperance is	*You are in the supermarket and see these apples:* 	*You are in the supermarket and see these apples:* 	*Neither Option A or B*
the Size is	*Less than 3 inch diameter*	*More than 3 inch diameter*	
the Firmness is	*Firm*	*Moderately firm*	
the Crispness is	*Not crisp*	*Very crisp*	
the Flavor is	*Intense apple flavor*	*Mild apple flavor*	
the Shelf life at home is	*Will last less than 1 week at home in your refrigerator*	*Will last more than 1 week at home in your refrigerator*	
the Price is	*$1.39/lb*	*$2.99/lb*	

Scenario 6

For this scenario, there will be TWO OPTIONS simulating a situation in which you BUY fruit. You have the opportunity to visually inspect the apple and evaluate the external appearance and size. You can try/eat the apple and evaluate its flesh texture, crispness, and flavor. You know the number of days the apple will last at home in your refrigerator. Price per pound varies for each option presented.

Please indicate which option (only ONE: either Option A or Option B) that best fits your preferences or if you do not like any option, choose "Neither Option A or B"

	Option A	*Option B*	*Neither Option A or B*
the External apperance is	*You are in the supermarket and see these apples:*	*You are in the supermarket and see these apples:*	*Neither Option A or B*

		
the Size is	*More than 3 inch diameter*	*Less than 3 inch diameter*
the Firmness is	*Firm*	*Moderately firm*
the Crispness is	*Very crisp*	*Not crisp*
the Flavor is	*Intense apple flavor*	*Mild apple flavor*
the Shelf life at home is	*Will last less than 1 week at home in your refrigerator*	*Will last more than 1 week at home in your refrigerator*
the Price is	*$1.39/lb*	*$2.99/lb*

Scenario 7

For this scenario, there will be TWO OPTIONS simulating a situation in which you BUY fruit. You have the opportunity to visually inspect the apple and evaluate the external appearance and size. You can try/eat the apple and evaluate its flesh texture, crispness, and flavor. You know the number of days the apple will last at home in your refrigerator. Price per pound varies for each option presented.

Please indicate which option (only ONE: either Option A or Option B) that best fits your preferences or if you do not like any option, choose "Neither Option A or B"

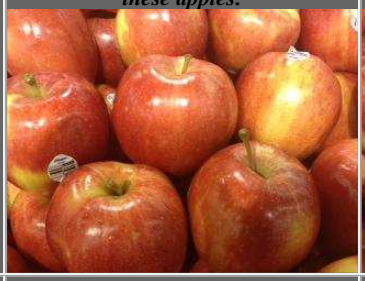
	Option A	*Option B*	*Neither Option A or B*
the External apperance is	*You are in the supermarket and see these apples:* 	*You are in the supermarket and see these apples:* 	*Neither Option A or B*
the Size is	*More than 3 inch diameter*	*Less than 3 inch diameter*	
the Firmness is	*Firm*	*Moderately firm*	
the Crispness is	*Not crisp*	*Very crisp*	
the Flavor is	*Mild apple flavor*	*Intense apple flavor*	

the Shelf life at home is	*Will last less than 1 week at home in your refrigerator*	*Will last more than 1 week at home in your refrigerator*	
the Price is	*$2.99/lb*	*$1.39/lb*	

Scenario 8

For this scenario, there will be TWO OPTIONS simulating a situation in which you BUY fruit. You have the opportunity to visually inspect the apple and evaluate the external appearance and size. You can try/eat the apple and evaluate its flesh texture, crispness, and flavor. You know the number of days the apple will last at home in your refrigerator. Price per pound varies for each option presented.

Please indicate which option (only ONE: either Option A or Option B) that best fits your preferences or if you do not like any option, choose "Neither Option A or B"

	Option A	*Option B*	*Neither Option A or B*
the External apperance is	*You are in the supermarket and see these apples:* 	*You are in the supermarket and see these apples:* 	*Neither Option A or B*
the Size is	*Less than 3 inch diameter*	*More than 3 inch diameter*	
the Firmness is	*Firm*	*Moderately firm*	
the Crispness is	*Very crisp*	*Not crisp*	
the Flavor is	*Mild apple flavor*	*Intense apple flavor*	
the Shelf life at home is	*Will last more than 1 week at home in your refrigerator*	*Will last less than 1 week at home in your refrigerator*	
the Price is	*$2.99/lb*	*$1.39/lb*	

When you go grocery shopping, how many people (including yourself) are you usually buying for?

- ☐ One
- ☐ Two
- ☐ Three
- ☐ Four
- ☐ Five or more

How many of these individuals that you shop for are under the age of 18?

- None
- One
- Two
- Three
- Four or more

How old are you?

- 18-24 yrs
- 25-34 yrs
- 35-44 yrs
- 45-54 yrs
- 55-64 yrs
- 65+ yrs

What is your gender.

- Female
- Male

What is the highest level of education you have completed.

- Less than high school
- High school degree
- 2 year college or technical/other degree
- 4 year college degree
- Advanced college degree

Which best describes your racial-ethnic identity?

- American Indian or Alaskan Native
- Asian, Asian American
- Black, African American, Non-Hispanic
- Hispanic or Latino American
- Middle Eastern, Middle Eastern American
- Pacific Islander
- White, European American, Non-Hispanic
- Other
- Decline to respond

Please indicate your total annual household income before taxes.

- Less than $25,000/yr
- $25,000-$34,999/yr
- $35,000-$49,999/yr
- $50,000-$74,999/yr
- $75,000-$99,999/yr
- $100,000/yr or more

APPENDIX C: Example Questions in Stawberry Producer Survey

1. **For the following questions, think about a potential strawberry variety you might grow for the "MAJOR USE" (fresh or processed). You will be presented eight different scenarios. For each scenario, there will be TWO OPTIONS simulating a situation in which you grow a potential strawberry variety with different combinations of fruit attributes and hypothetical total cost for production and handling. Please indicate which option A or B (only ONE) you prefer to grow at the SPECIFIED Total Cost or choose "Neither Option" if you do not like Option A or B. (*Please note these scenarios are simulated and might not reflect the current real situation on your farm/operation; but please answer these questions assuming you are now given these two options and let us know which option you would choose*).**

STRAWBERRY Scenario 1: *Check the box corresponding to the option you would choose.*

Attribute	***Option A:***	***Option B:***	***Option C:***
Size	Less than 25 g/fruit	More than 25 g/fruit	Neither Option
Internal color	Too light or too dark color	Ideal red color	
External color	Ideal red color	Too light or too dark color	
Firmness	Firm	Soft	
Flavor (Combination of sweetness, sweet/tart balance and aroma)	Weak/mild flavor	Full/intense flavor	
Shelf life	9 days after harvest	4 days after harvest	
Total cost of production/storage/handling	$1.00 /lb	$1.15 /lb	
Which option would you choose?	☐	☐	☐

STRAWBERRY Scenario 2: *Check the box corresponding to the option you would choose.*

Attribute	***Option A:***	***Option B:***	***Option C:***
Size	Less than 25 g/fruit	More than 25 g/fruit	Neither Option
Internal color	Ideal red color	Too light or too dark color	
External color	Ideal red color	Too light or too dark color	
Firmness	Firm	Soft	
Flavor (Combination of sweetness, sweet/tart balance and aroma)	Full/intense flavor	Weak/mild flavor	
Shelf life	9 days after harvest	4 days after harvest	
Total cost of production/storage/handling	$1.15 /lb	$1.00 /lb	

Which option would you choose?	☐	☐	☐

STRAWBERRY Scenario 3: *Check the box corresponding to the option you would choose.*

Attribute	***Option A:***	***Option B:***	***Option C:***
Size	Less than 25 g/fruit	More than 25 g/fruit	Neither Option
Internal color	Ideal red color	Too light or too dark color	
External color	Too light or too dark color	Ideal red color	
Firmness	Firm	Soft	
Flavor (Combination of sweetness, sweet/tart balance and aroma)	Weak/mild flavor	Full/intense flavor	
Shelf life	4 days after harvest	9 days after harvest	
Total cost of production/storage/handling	$1.00 /lb	$1.15 /lb	
Which option would you choose?	☐	☐	☐

STRAWBERRY Scenario 4: *Check the box corresponding to the option you would choose.*

Attribute	***Option A:***	***Option B:***	***Option C:***
Size	More than 25 g/fruit	Less than 25 g/fruit	Neither Option
Internal color	Too light or too dark color	Ideal red color	
External color	Ideal red color	Too light or too dark color	
Firmness	Firm	Soft	
Flavor (Combination of sweetness, sweet/tart balance and aroma)	Full/intense flavor	Weak/mild flavor	
Shelf life	4 days after harvest	9 days after harvest	
Total cost of production/storage/handling	$1.15 /lb	$1.00 /lb	
Which option would you choose?	☐	☐	☐

STRAWBERRY Scenario 5: *Check the box corresponding to the option you would choose.*

Attribute	***Option A:***	***Option B:***	***Option C:***
Size	Less than 25 g/fruit	More than 25 g/fruit	Neither

Internal color	Ideal red color	Too light or too dark color	Option
External color	Ideal red color	Too light or too dark color	
Firmness	Soft	Firm	
Flavor (Combination of sweetness, sweet/tart balance and aroma)	Full/intense flavor	Weak/mild flavor	
Shelf life	4 days after harvest	9 days after harvest	
Total cost of production/storage/handling	$1.15 /lb	$1.00 /lb	
Which option would you choose?	☐	☐	☐

STRAWBERRY-Scenario 6: *Check the box corresponding to the option you would choose.*

Attribute	***Option A:***	***Option B:***	***Option C:***
Size	More than 25 g/fruit	Less than 25 g/fruit	
Internal color	Ideal red color	Too light or too dark color	
External color	Too light or too dark color	Ideal red color	
Firmness	Firm	Soft	Neither Option
Flavor (Combination of sweetness, sweet/tart balance and aroma)	Full/intense flavor	Weak/mild flavor	
Shelf life	9 days after harvest	4 days after harvest	
Total cost of production/storage/handling	$1.15 /lb	$1.00 /lb	
Which option would you choose?	☐	☐	☐

STRAWBERRY Scenario 7: *Check the box corresponding to the option you would choose.*

Attribute	***Option A:***	***Option B:***	***Option C:***
Size	Less than 25 g/fruit	More than 25 g/fruit	
Internal color	Too light or too dark color	Ideal red color	
External color	Too light or too dark color	Ideal red color	
Firmness	Firm	Soft	Neither Option
Flavor (Combination of sweetness, sweet/tart balance and aroma)	Full/intense flavor	Weak/mild flavor	
Shelf life	4 days after harvest	9 days after harvest	

Total cost of production/storage/handling	$1.00 /lb	$1.15 /lb	
Which option would you choose?	☐	☐	☐

STRAWBERRY Scenario 8: *Check the box corresponding to the option you would choose.*

Attribute	***Option A:***	***Option B:***	***Option C:***
Size	More than 25 g/fruit	Less than 25 g/fruit	Neither Option
Internal color	Ideal red color	Too light or too dark color	
External color	Ideal red color	Too light or too dark color	
Firmness	Firm	Soft	
Flavor (Combination of sweetness, sweet/tart balance and aroma)	Weak/mild flavor	Full/intense flavor	
Shelf life	4 days after harvest	9 days after harvest	
Total cost of production/storage/handling	$1.15 /lb	$1.00 /lb	
Which option would you choose?	☐	☐	☐

PLEASE TELL US ABOUT YOUR OPERATION

2. **How many total acres of strawberry farms do you own or manage?** (*Check only one category*.)

- ❑ < 5
- ❑ 5 to 14
- ❑ 15 to 24
- ❑ 25 to 49
- ❑ 50 to 99
- ❑ 100 to 249
- ❑ 250 to 499
- ❑ 500 to 1,000
- ❑ > 1,000

3. In what zip code (or zip codes) are your strawberry farms located?

_____

4. **Which of the following business structures best describes your strawberry farm operation?** (*Check only one category.*)

- ❑ Family or individual operation (excluding partnerships and corporations)
- ❑ Family partnership
- ❑ Family corporation
- ❑ Partnership, other than family
- ❑ Corporation, other than family
- ❑ Educational, research, or non-profit farm
- ❑ Other *please explain*:_____

5. **Which of the following categories best represents the 2010 growing season gross income from ALL your strawberry farms?** (*Check only one category.*)

- ❑ < $25,000
- ❑ $25,000 - $49,999
- ❑ $50,000 - $74,999
- ❑ $75,000 - $99,999
- ❑ $100,000 - $249,999
- ❑ $250,000 - $499,999
- ❑ $500,000 - $999,999
- ❑ $1,000,000 - $2,499,999
- ❑ > $2,500,000

6. **Approximately what percentage of your total household income comes from ALL your strawberry farm operation**?

❑ 0% ❑ 1–25% ❑ 26–50% ❑ 51–75%
❑ 76–99% ❑ 100%

7. What percentage of your <u>strawberry acres</u> was covered under a crop insurance policy in the 2010 growing season?
_____ % or ❑ <u>None</u>

PLEASE TELL US ABOUT YOURSELF

8. Are you male or female?

❑ Male ❑ Female

9. **How old are you?** _____ years old.

10. For how many years have you been involved in strawberry production as an orchard owner, manager, or primary decision maker?

_____ years

11. **Which of the following categories best describes your ethnic and racial background? (*Please check all that apply*.)**

❑ Caucasian or White
❑ Spanish, Hispanic, or Latino
❑ Black or African American
❑ American Indian or Alaska Native
❑ Asian, Asian American, or Pacific Islander
❑ Other: _____

12. What is the highest level of formal education that you have completed? (*Please check the one answer that best applies*.)

❑ Some high school or less
❑ High school diploma or equivalent

- ❑ Some college, but no degree
- ❑ Vocational or Extension certificate
- ❑ Two-year college degree
- ❑ Four-year college degree
- ❑ Some graduate school
- ❑ Graduate degree

IF YOU HAVE ANY ADDITIONAL COMMENTS YOU WOULD LIKE TO SHARE WITH US, PLEASE WRITE THEM IN THE SPACE BELOW.

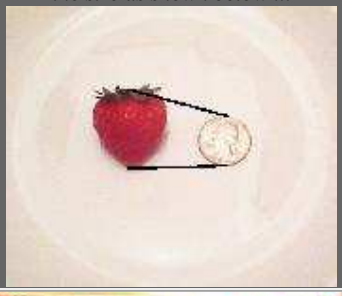
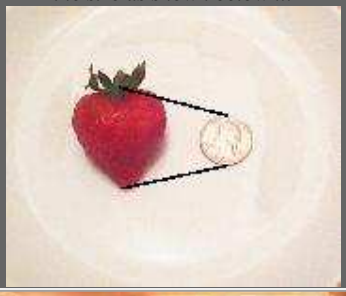
APPENDIX D: Example Questions in Consumer Strawberry Survey

For the following questions, you will be presented with eight different scenarios. For each scenario,there will be TWO OPTIONS simulating a situation in which you BUY fruit. Please indicate which option (only ONE) best fits your preferences or choose "Neither Option" if you do not like Option A or B.

Scenario 1

For each scenario, there will be TWO OPTIONS simulating a situation in which you BUY fruit. You have the opportunity to visually inspect the strawberry and evaluate the external appearance, the internal appearance and size. You can try/eat the strawberry and evaluate its flesh texture and flavor. You know the number of days the strawberry will last at home in your refrigerator. Price per pound varies for each option presented.

Please indicate which option (only ONE: either Option A or Option B) that best fits your preferences or if you do not like any option, choose "Neither Option A or B"

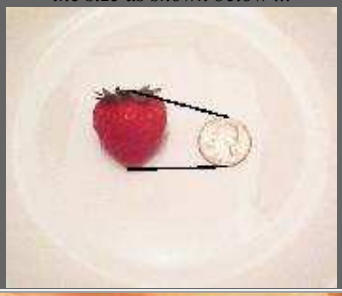
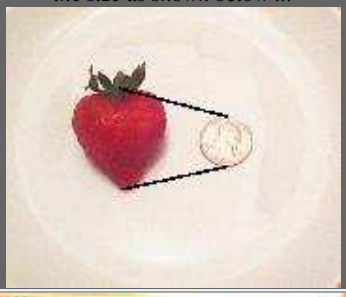
	Option A	***Option B***	***Neither Option A or B***
the External color is	*You are in the supermarket and see these strawberries:* 	*You are in the supermarket and see these strawberries:* 	***Neither Option A or B***
the Size is	*Most strawberries in the clam shell are the size as shown below ...* 	*Most strawberries in the clam shell are the size as shown below ...* 	
the Internal color is			
the Texture is	***Firm***	***Soft***	

the Flavor is	***Mild strawberry flavor***	***Intense strawberry flavor***	
the Shelf life at home is	***Will last 9 days at home in your refrigerator***	***Will last 4 days at home in your refrigerator***	
the Price is	***$2.99/lb***	***$2.65/lb***	

Scenario 2

For each scenario, there will be TWO OPTIONS simulating a situation in which you BUY fruit. You have the opportunity to visually inspect the strawberry and evaluate the external appearance, the internal appearance and size. You can try/eat the strawberry and evaluate its flesh texture and flavor. You know the number of days the strawberry will last at home in your refrigerator. Price per pound varies for each option presented.

Please indicate which option (only ONE: either Option A or Option B) that best fits your preferences or if you do not like any option, choose "Neither Option A or B"

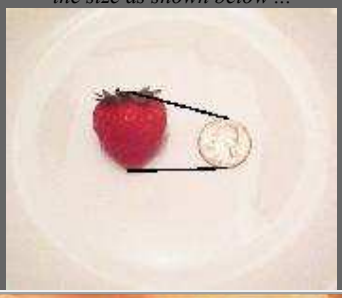
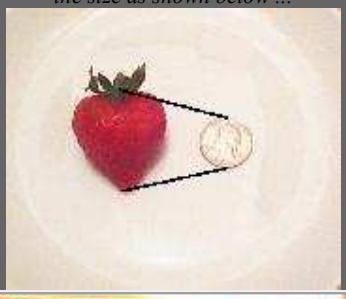
	Option A	***Option B***	***Neither Option A or B***
the External color is	*You are in the supermarket and see these strawberries:* 	*You are in the supermarket and see these strawberries:* 	***Neither Option A or B***
the Size is	*Most strawberries in the clam shell are the size as shown below ...* 	*Most strawberries in the clam shell are the size as shown below ...* 	
the Internal color is			
the Texture is	***Firm***	***Soft***	
the Flavor is	***Intense strawberry flavor***	***Mild strawberry flavor***	
the Shelf life at	***Will last 9 days at home in your***	***Will last 4 days at home in your***	

home is	***refrigerator***	***refrigerator***	
the Price is	***$2.99/lb***	***$2.65/lb***	

Scenario 3

For each scenario, there will be TWO OPTIONS simulating a situation in which you BUY fruit. You have the opportunity to visually inspect the strawberry and evaluate the external appearance, the internal appearance and size. You can try/eat the strawberry and evaluate its flesh texture and flavor. You know the number of days the strawberry will last at home in your refrigerator. Price per pound varies for each option presented.

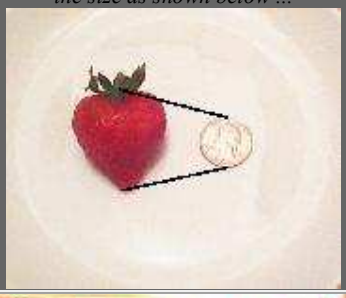
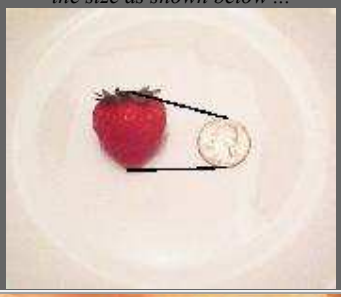
Please indicate which option (only ONE: either Option A or Option B) that best fits your preferences or if you do not like any option, choose "Neither Option A or B"

	Option A	***Option B***	***Neither Option A or B***
the External color is	*You are in the supermarket and see these strawberries:* 	*You are in the supermarket and see these strawberries:* 	***Neither Option A or B***
the Size is	*Most strawberries in the clam shell are the size as shown below ...* 	*Most strawberries in the clam shell are the size as shown below ...* 	
the Internal color is			
the Texture is	***Firm***	***Soft***	
the Flavor is	***Mild strawberry flavor***	***Intense strawberry flavor***	
the Shelf life at home is	***Will last 4 days at home in your refrigerator***	***Will last 9 days at home in your refrigerator***	
the Price is	***$2.99/lb***	***$2.65/lb***	

Scenario 4

For each scenario, there will be TWO OPTIONS simulating a situation in which you BUY fruit. You have the opportunity to visually inspect the strawberry and evaluate the external appearance, the internal appearance and size. You can try/eat the strawberry and evaluate its flesh texture and flavor. You know the number of days the strawberry will last at home in your refrigerator. Price per pound varies for each option presented.

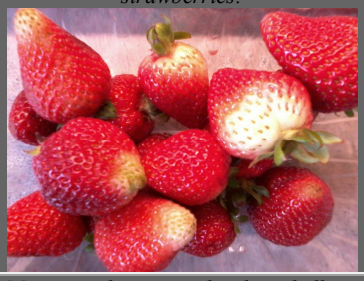
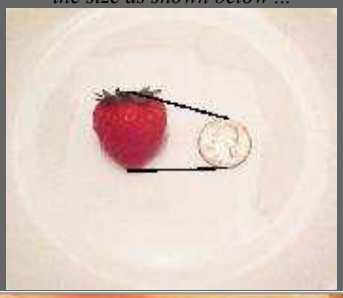
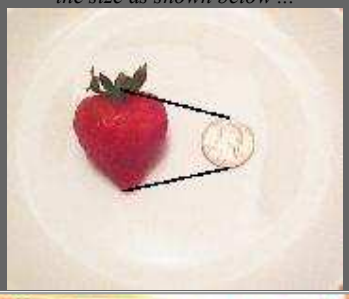
Please indicate which option (only ONE: either Option A or Option B) that best fits your preferences or if you do not like any option, choose "Neither Option A or B"

	Option A	***Option B***	***Neither Option A or B***
the External color is	*You are in the supermarket and see these strawberries:* 	*You are in the supermarket and see these strawberries:* 	***Neither Option A or B***
the Size is	*Most strawberries in the clam shell are the size as shown below ...* 	*Most strawberries in the clam shell are the size as shown below ...* 	
the Internal color is			
the Texture is	***Firm***	***Soft***	
the Flavor is	***Intense strawberry flavor***	***Mild strawberry flavor***	
the Shelf life at home is	***Will last 4 days at home in your refrigerator***	***Will last 9 days at home in your refrigerator***	
the Price is	***$2.99/lb***	***$2.65/lb***	

Scenario 5

For each scenario, there will be TWO OPTIONS simulating a situation in which you BUY fruit. You have the opportunity to visually inspect the strawberry and evaluate the external appearance, the internal appearance and size. You can try/eat the strawberry and evaluate its flesh texture and flavor. You know the number of days the strawberry will last at home in your refrigerator. Price per pound varies for each option presented.

Please indicate which option (only ONE: either Option A or Option B) that best fits your preferences or if you do not like any option, choose "Neither Option A or B"

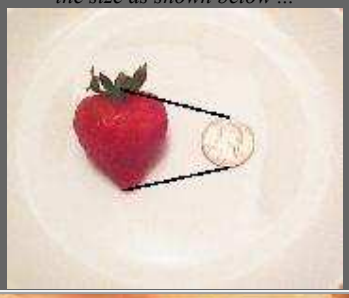
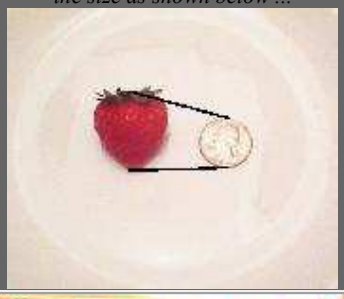
	Option A	***Option B***	***Neither Option A or B***
the External color is	*You are in the supermarket and see these strawberries:* 	*You are in the supermarket and see these strawberries:* 	***Neither Option A or B***
the Size is	*Most strawberries in the clam shell are the size as shown below ...* 	*Most strawberries in the clam shell are the size as shown below ...* 	
the Internal color is			
the Texture is	***Soft***	***Firm***	
the Flavor is	***Intense strawberry flavor***	***Mild strawberry flavor***	
the Shelf life at home is	***Will last 4 days at home in your refrigerator***	***Will last 9 days at home in your refrigerator***	
the Price is	***$2.65/lb***	***$2.99/lb***	

Scenario 6

For each scenario, there will be TWO OPTIONS simulating a situation in which you BUY fruit. You

have the opportunity to visually inspect the strawberry and evaluate the external appearance, the internal appearance and size. You can try/eat the strawberry and evaluate its flesh texture and flavor. You know the number of days the strawberry will last at home in your refrigerator. Price per pound varies for each option presented.

Please indicate which option (only ONE: either Option A or Option B) that best fits your preferences or if you do not like any option, choose "Neither Option A or B"

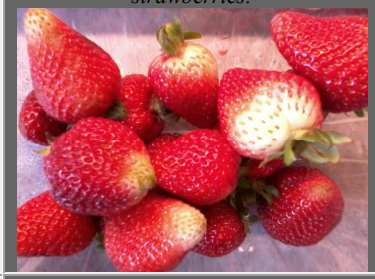
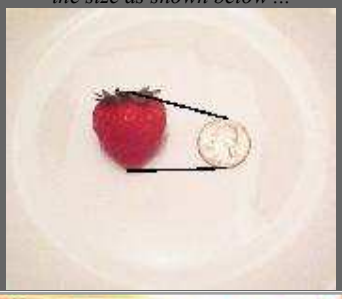
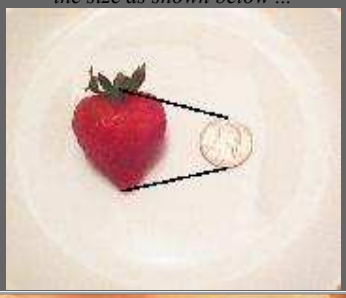
	Option A	***Option B***	***Neither Option A or B***
the External color is	*You are in the supermarket and see these strawberries:* 	*You are in the supermarket and see these strawberries:* 	***Neither Option A or B***
the Size is	*Most strawberries in the clam shell are the size as shown below ...* 	*Most strawberries in the clam shell are the size as shown below ...* 	
the Internal color is			
the Texture is	***Firm***	***Soft***	
the Flavor is	***Intense strawberry flavor***	***Mild strawberry flavor***	
the Shelf life at home is	***Will last 9 days at home in your refrigerator***	***Will last 4 days at home in your refrigerator***	
the Price is	***$2.65/lb***	***$2.99/lb***	

Scenario 7

For each scenario, there will be TWO OPTIONS simulating a situation in which you BUY fruit. You have the opportunity to visually inspect the strawberry and evaluate the external appearance, the internal appearance and size. You can try/eat the strawberry and evaluate its flesh texture and flavor. You know the number of days the strawberry will last at home in your refrigerator. Price per

pound varies for each option presented.

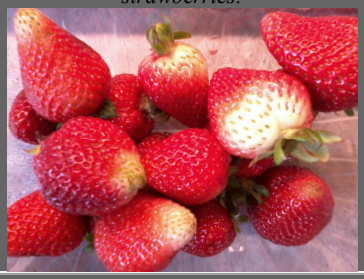
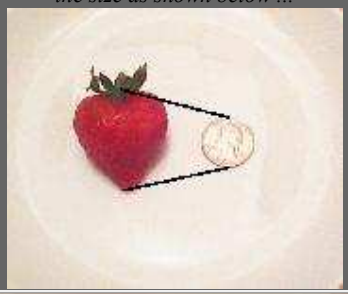
Please indicate which option (only ONE: either Option A or Option B) that best fits your preferences or if you do not like any option, choose "Neither Option A or B"

	Option A	***Option B***	***Neither Option A or B***
the External color is	*You are in the supermarket and see these strawberries:* 	*You are in the supermarket and see these strawberries:* 	***Neither Option A or B***
the Size is	*Most strawberries in the clam shell are the size as shown below ...* 	*Most strawberries in the clam shell are the size as shown below ...* 	
the Internal color is			
the Texture is	***Firm***	***Soft***	
the Flavor is	***Intense strawberry flavor***	***Mild strawberry flavor***	
the Shelf life at home is	***Will last 4 days at home in your refrigerator***	***Will last 9 days at home in your refrigerator***	
the Price is	***$2.99/lb***	***$2.65/lb***	

Scenario 8

For each scenario, there will be TWO OPTIONS simulating a situation in which you BUY fruit. You have the opportunity to visually inspect the strawberry and evaluate the external appearance, the internal appearance and size. You can try/eat the strawberry and evaluate its flesh texture and flavor. You know the number of days the strawberry will last at home in your refrigerator. Price per pound varies for each option presented.

Please indicate which option (only ONE: either Option A or Option B) that best fits your preferences or if you do not like any option, choose "Neither Option A or B"

	Option A	***Option B***	***Neither Option A or B***
the External color is	*You are in the supermarket and see these strawberries:* 	*You are in the supermarket and see these strawberries:* 	***Neither Option A or B***
the Size is	*Most strawberries in the clam shell are the size as shown below ...* 	*Most strawberries in the clam shell are the size as shown below ...* 	
the Internal color is			
the Texture is	***Firm***	***Soft***	
the Flavor is	***Mild strawberry flavor***	***Intense strawberry flavor***	
the Shelf life at home is	***Will last 4 days at home in your refrigerator***	***Will last 9 days at home in your refrigerator***	
the Price is	***$2.99/lb***	***$2.65/lb***	

When you go grocery shopping, how many people (including yourself) are you usually buying for?

- ☐ One
- ☐ Two
- ☐ Three
- ☐ Four
- ☐ Five or more

How many of these individuals that you shop for are under the age of 18?

- None
- One
- Two
- Three
- Four or more

How old are you?

- 18-24 yrs
- 25-34 yrs
- 35-44 yrs
- 45-54 yrs
- 55-64 yrs
- 65+ yrs

What is your gender.

- Female
- Male

What is the highest level of education you have completed.

- Less than high school
- High school degree
- 2 year college or technical/other degree
- 4 year college degree
- Advanced college degree

Which best describes your racial-ethnic identity?

- American Indian or Alaskan Native
- Asian, Asian American
- Black, African American, Non-Hispanic
- Hispanic or Latino American
- Middle Eastern, Middle Eastern American
- Pacific Islander
- White, European American, Non-Hispanic
- Other
- Decline to respond

Please indicate your total annual household income before taxes.

- Less than $25,000/yr
- $25,000-$34,999/yr
- $35,000-$49,999/yr
- $50,000-$74,999/yr
- $75,000-$99,999/yr

- $100,000/yr or more